Factors INFLUENCING PRODUCTION of WHITE-TAILED DEER ON THE COEUR d'ALENE NATIONAL FOREST, IDAHO

BY

WILLIAM LESLIE PENGELLY

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FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE

NORTHERN REGION MISSOULA, MONTANA

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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
NORTHERN REGION

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MISSOULA, MONTANA

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May 1, 1961

This manuscript was prepared by W. Leslie Pengelly in partial fulfillment of the requirements for a Doctor of Philosophy Degree in Wildlife Management at Utah State University.

The report is the culmination of a ten-year cooperative study between the U. S. Forest Service and the Idaho Fish and Game Department. The author was employed by the latter agency during the early stages of the study. Since 1954 Mr. Pengelly has been employed by Montana State University and the Montana Fish and Game Department as Wildlife Extension Specialist for western Montana.

Because of the importance of the findings and the value of the information to forest officers and others concerned with wildlife management in the national forests, the U. S. Forest Service made arrangements with Mr. Pengelly to reproduce the report for official use by forest officers and cooperating agencies.

The report is reproduced in its entirety as submitted to Utah State University, except for the acknowledgement page which listed many individuals but "especially the personnel of the Northern Region of the U. S. Forest Service and the Idaho Fish and Game Department whose wholehearted cooperation made this study possible."

Boyd L. Rasmussen

Boyd L. Rasmussen, Regional Forester

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INTRODUCTION

The white-tailed deer (Odoccileus virginianus) has long been an object of particular interest because of its abundance, its almost continent-wide distribution, and its ability to adapt to changing conditions.

These characteristics have made the white-tailed deer the number one big game animal in the United States, and also "makes them the most susceptible of all to game management" (Taylor, 1956). Many of the current problems of managing deer can be solved with proper understanding and support from the general public but misinformation and misguided sentiment in many quarters is hampering good management. Management plans are further complicated by the fact that deer are variable in their habits from place to place.

Northern Idaho's mountainous physiographic features and accompanying extremes of weather affect the deer populations both directly and indirectly. The combination of climate, drainage pattern, steep slopes and aspects of slope produce a characteristic flora, which in turn affects land use in the area and determines the animal life in the association. This report discusses and attempts to evaluate the factors that are influencing white-tailed deer production on a marginal range in a heavy snowfall area. It concerns the ecology and management of the northwest white-tailed deer (O.v.ochrourus) on the Coeur d'Alene National Forest and contiguous private lands in northern Idaho. The investigation was carried on cooperatively by the Idaho Fish and Game

Department and the United States Forest Service. The study was begun under the Federal Aid in Wildlife Restoration Act, Project W90-R, "Coeur d'Alene Deer Management Study," from August 1949 to October 1951, and from June 1952 to February 1954. Additional field work in the summers of 1957 and 1959 was financed by the author, with partial assistance in the form of a grant from the Wildlife Management Institute.

Game studies have been carried on in northern Idaho by the Forest Service as part of its regular winter duties since 1916. From 1935-37 funds were available for winter game studies under the Emergency Relief Administration /E.R.A./ (U.S. Forest Service, 1935-37). These studies emphasized the apparent low numbers of game for what appeared to be abundant available forage.

Since the close of World War II the Idaho Fish and Game Department has taken an active interest in the game herds of the Coeur d'Alene National Forest. The advent of Federal Aid funds for wildlife research and an extremely heavy winter kill of deer in 1948-49 prompted the initiation of this study in August 1949.

The heavily timbered mountains which were once inaccessible are now crisscrossed with roads that allow access for the thousands of people residing on the periphery. The heavy recreational use consists of fishing, hunting, picnicking, camping and motoring. As the hunting pressure increases on a deer herd it becomes necessary for the land and game management agencies to get more detailed information on their numbers, ranges, and survival in order to secure better management.

Early Forest Service game estimates (1920) indicated that deer were in low numbers. Excessive use of deer by miners and others for food in the early days, coupled with uncontrolled predation, large fires that

temporarily destroyed food and cover, and periodic severe winter losses on these marginal ranges did much to keep numbers at a low point.

Gradually this was reversed by better law enforcement, control of fires, opening up of virgin timber stands by logging, and predator control, with a resultant increase in all species of big game. Periodic heavy winter deer die-offs continued to occur, however, and the general feeling was that for the apparent amount of feed available, the forest was understocked with deer in 1949. The usual suggestions were made to close seasons, to provide supplemental feed, and to kill predators, with no attempt to analyze range and herd conditions.

Purpose of Study

Big game management traditionally attempts to determine range carrying capacities and to increase or decrease big game populations to achieve an approximate balance between the two. Since the Coeur d'Alene ranges were believed by some game administrators and sportsmen to be understocked, the first objective was to determine the factors, if any, that were limiting white-tailed deer populations.

The second major objective was to work out recommendations for a management plan. Unfortunately there are apparent and real contradictions and conflicts existing between game management agencies and the general public. Current management is not always consistent with the highest type of management possible so some attempt should be made to encourage public support through an understanding of the issues. Management of resident game is the responsibility of the State, yet the public sometimes prevents the State from fulfilling that responsibility. The obvious sequence then is to get the facts and present them to the public.

in such a way that they will want to support the management program.

This study was not primarily designed to produce life history data on a game species about which abundant writings have already been produced. Productivity and mortality data were collected and evaluated with reference to known standards of performance of this species in an attempt to determine factors limiting local population increases. The need, as stated by Taylor (1956) in his preface to the deer monograph, is to fill in the gaps in our knowledge of the species, both functional and geographical. This study presents findings from 1949 to 1959 regarding conditions and extent of available range, status of white-tailed deer populations, and recommendations for future management.

Description of the Study Area

Location

The deer study area, the Coeur d'Alene National Forest, and southeast portion of the Kaniksu National Forest, is located in the Bitterroot Mountains of northern Idaho. It is bounded on the south by the main Coeur d'Alene River and its South Fork; on the west by Highway 95; on the north by the Bonner County line, Lake Pend Oreille and the Clark's Fork River; and its eastern boundary is the Montana-Idaho divide, south to U. S. Highway 10. It embraces the northern half of Shoshone County and the eastern half of Kootenai County with a small portion of southern Bonner County comprising the north end of the area (Figure 1). The interior, or intermountain area of heavy snowfall, and the exterior or outer foothills area, having only moderate snowfall and more gentle topography, both represent range types found extensively in northern Idaho. The findings on deer ecology with relation to land use thus have some reliance over a considerable region.

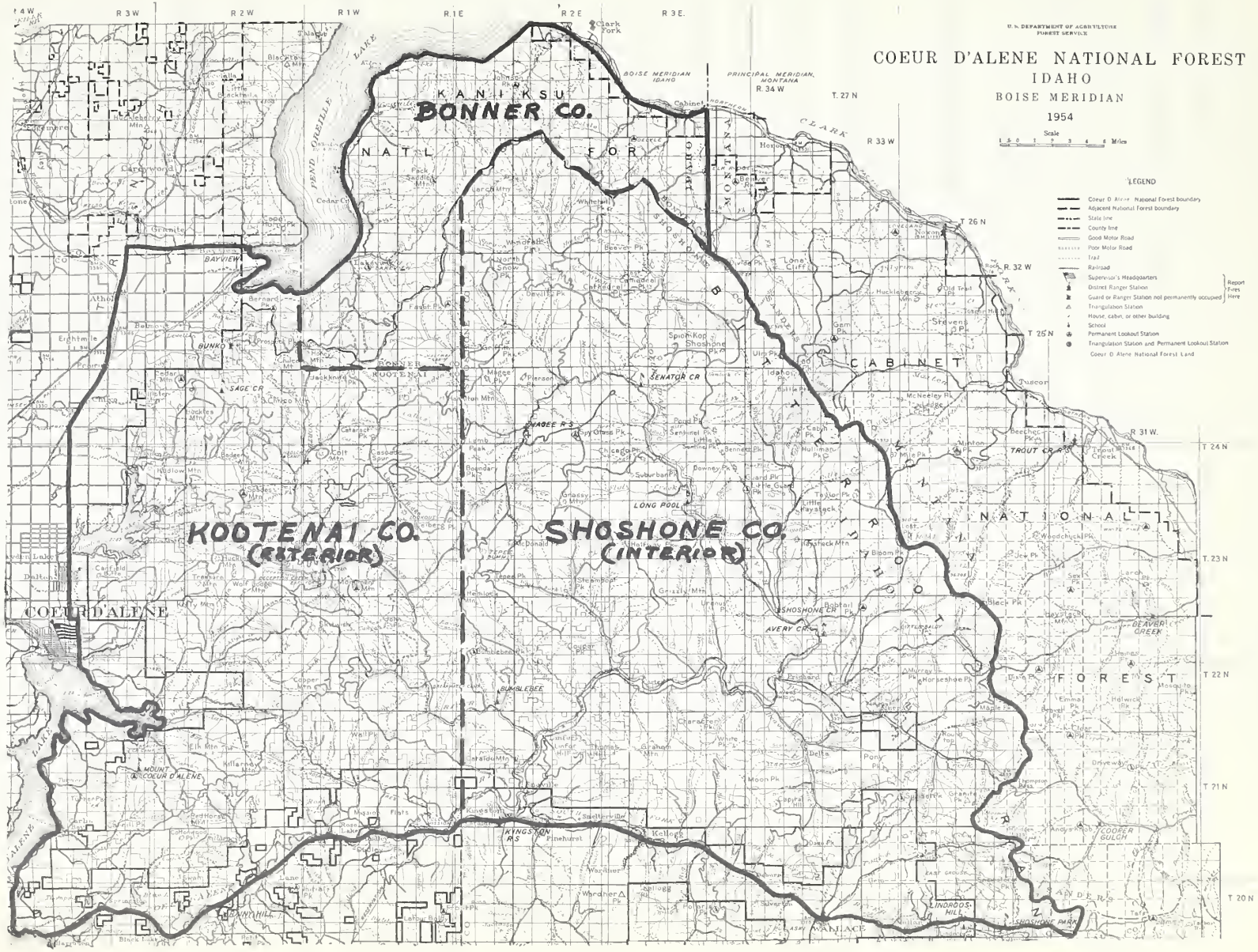


Fig. 1 Map of the study area

The study area is divided into two different vegetational and climatic zones: (a) the interior of the forest in northern Shoshone County, and (b) the exterior or periphery which is mostly found in eastern Kootenai County, with a small portion occurring in southeastern Bonner County. The following discussion therefore will take up these two areas separately.

Size and ownership

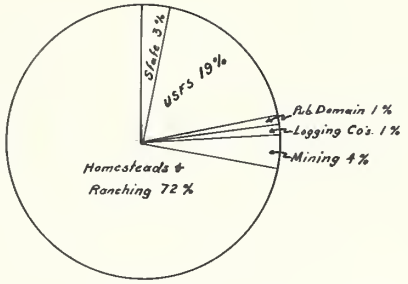
The study area as a whole comprises approximately 1,015,000 acres of private and National Forest lands. About one-fifth of this area is occupied by the deer in winter. Figure 2, which gives a proportion by land ownership within the winter range, shows that public lands comprise only 36 percent of the total area of 215,185 acres as used by white-tailed deer during an average winter.

Railroad land grants, homesteading and a rush for mining claims by the 1800's produced a very complicated land ownership pattern over the study area. These activities caused a rapid expansion of logging as early as 1886. By 1906 the Coeur d'Alene National Forest was established, absorbing most of the unacquired lands which comprised the more mountainous portions of Kootenai and Shoshone Counties.

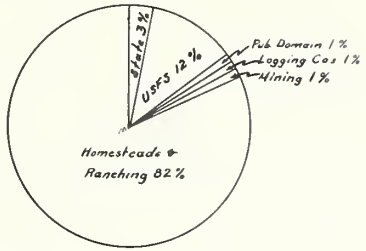
Subsequently, some homesteads have reverted to the county for tax delinquency but the most pronounced change has been in the holdings of large logging companies which cut the white pine and then traded most of their lands to the Forest Service. Today the timber holdings by large logging companies is considerably less than it was in the 1920's.

The total available wintering areas for severe and average winters have been mapped, and the study area was divided into eleven sub-units (Figure 8) for purposes of analysis. Figure 2 gives a percentage breakdown of the class of ownership of those acres for severe and average

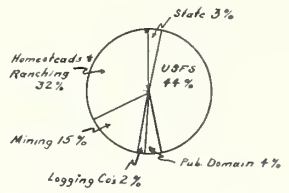
A-MINIMUM WINTER RANGE (1949-50)



TOTAL AREA
82452 ACRES

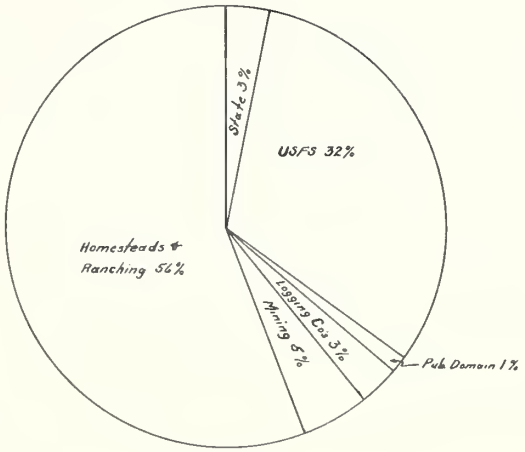


KOOTENAI COUNTY
65305 ACRES (79%)

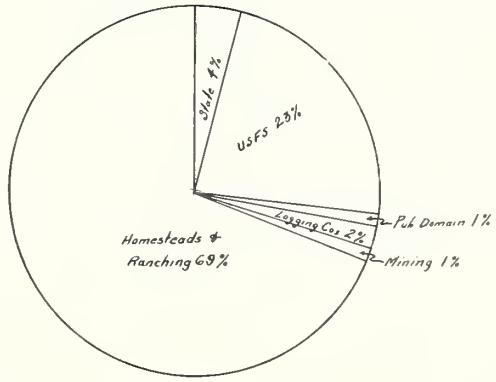


SHOSHONE COUNTY
17147 ACRES (21%)

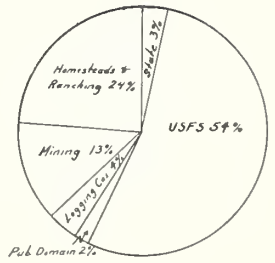
B-AVERAGE WINTER RANGE (1950-51)



TOTAL AREA
215185 ACRES



KOOTENAI COUNTY
149306 ACRES (69%)



SHOSHONE COUNTY
65879 ACRES (31%)

Fig.-2 LAND OWNERSHIP OF WINTER RANGES FOR WHITE-TAILED DEER

winters.

Two conclusions are apparent to one examining the data. The first is that the bulk of the winter range for white-tailed deer, whether during an average or severe winter, is on privately-owned lands. Secondly, the major portion of the whitetail winter range lies in the first four study sub-units, which are located primarily in Kootenai and Bonner Counties, along the foothills and flats of the exterior part of the study area. The exterior portion (sub-units 1 to 4) furnishes from 69 to 79 percent of the available winter range for whitetails during average and severe winters in this study area. Shoshone County, in the interior, furnishes the remainder.

According to the 1950 range survey there are 17,147 acres of land classed as minimum winter range in Shoshone County (Figure 2), of which 49 percent (8402 acres) is in private ownership and 51 percent (8745) is in public ownership. The winter range is a narrow band along the length of the river bottoms, but with roads, ranches and other human use of these lands, the total usable range for deer is only about 10,397 acres (Table 19).

In Kootenai County there is a smaller loss to rivers and roads, a larger loss to cultural wastes, a similar composition of desirable and undesirable species, but with average snow depths much less than on interior ranges. It is more extensive that the interior area and so it has a greater potential as white-tailed deer range. There are 10,000 acres of public lands and 55,305 acres of privately owned lands used by white-tailed deer in this exterior region during very severe winters.

The present winter ranges for white-tailed deer in the exterior portion of the study area (Figure 8) are largely confined to privately

owned cut-over lands along the rivers and foothills, with cut-over lands administered by the Forest Service adjacent to these public holdings being of secondary importance (Anon. 1927-38). Any attempt to increase white-tailed deer numbers in either county will have to take into account the fact that much of their critical winter range is privately owned.

Geology

The study area lies on the western slope of that northward prolongation of the Bitterroot range called the Coeur d'Alene Mountains (Campbell, 1915). This range has a more uniform relief than the ranges north of it and consists of a rather monotonous expanse of ridges of equal height and without prominent summits. The general upper level is from 5,000 to 6,000 feet with a few peaks approaching 7,000 feet.

At Cataldo where the Coeur d'Alene River crosses the county line, the elevation is only 2,142 feet, the lowest point in the whole study area.

During the Pleistocene the high mountains of the central and northern regions (of Idaho) were characterized by local mountain glaciers, and in addition the northern tip of the state was twice invaded by continental ice sheets, leaving the larger valleys floored with deep glacial and fluvial deposits. During the first of these two glacial periods the ice was so deep that it submerged all but the summits of the highest peaks (Daubenmire, 1945).

This region is characterized by narrow canyons and broad valleys due to great faults in the rocks. The dropped or tilted blocks formed the broad valleys and the rivers, which became obstructed by the raised blocks, cut narrow canyons (Cabinet Gorge, Mullan-Wallace) through the

hard rocks.

Rathdrum Valley (Kootenai County) on the western foothills is a huge granite block overlain with glacial drift averaging about 2,000 feet in elevation. Hayden, Pend Oreille, and Coeur d'Alene Lakes were all formed by the damming of lateral valleys by glacial moraines. At one stage in the formation of the area the great Columbia River basalt flow sent one lobe to the east where it flowed against the mountains (Hayden rimrock) and extended up the valleys, where it is now largely covered by gravel.

The Coeur d'Alene River drainage (Figure 1), approximately 100 miles long, consists of steep timbered terrain in the upper reaches with broad rolling meadowlands lower down. The South Fork of the Coeur d'Alene River is a remarkably straight depression, the position of which was determined by easy erosion along a zone characterized by extensive faulting. The North Fork enters at Enaville and below the junction the valley becomes broader down to its mouth at Coeur d'Alene Lake. The valley of the South Fork for the most part is fairly broad although it passes through a gorge between Wallace and Mullan. The upper North Fork valley has an average width of about one-half mile along most of its length.

Soils

The Soil Conservation Service (U.S.F.S., Coeur d'Alene National Forest files) has listed Shoshone County, which covers much of the mountainous interior of the study area, as 1 percent agricultural and 99 percent non-agricultural land. Little has been done on the study of these soils. General observations indicate that most of the local forest soils contain very little humus and are characterized by

gravelly or stony subsoils (lithosols) which create excessive drainage. They are acid, thin, geologically young soils of shale origin. The river bottoms contain local deposits of alluvium which are fairly fertile. Most of these flats are utilized by ranches and small farms.

Along the North Fork are marginal flats of fairly good land suitable for occasional cultivation. These soils are deep and medium textured with permeable subsoils. Climate, principally through the short growing season, has a greater effect in limiting agriculture here than does soil fertility. Excessive disturbance of the surface by log drives, floods and "scour" ice in the upper flats has caused considerable soil erosion.

Although the valley bottoms involve only 1 percent of the total land area of the region, these alluvial soils constitute the bulk of the white-tailed deer winter ranges (Figure 8). This is due to more than soil fertility. Topography and plant cover also influence white-tailed deer distribution.

Climate and Weather

An examination of station records[1] reveals that the Coeur d'Alene (representing exterior conditions) and Wallace (representing interior conditions) records can be used to determine broadly the differences that exist between these two portions of the study area. The original records were used in all cases.

The heaviest snowfall ever recorded in Idaho was from Shoshone County near the Montana border and total precipitation figures for that area usually lead the state. Why this is true is best illustrated in the following summary:

[1]Climatological Bulletins, U. S. Weather Bureau, Boise, Idaho, 1916-1953.

> Because of the intervening north south mountains to the west of the state, especially the Cascade Range, which rob the eastward-moving winds of much of their moisture, precipitation is light except at the higher elevations. There are alternating mountain ranges and lower, comparatively flat intervening areas from the coast of Washington to northern Idaho. In the Olympic Mountains, in western Washington, the average annual precipitation is considerable in excess of 100 inches, while to the leeward, in the Puget Sound area, this is reduced to 40 to 50 inches. The amount of precipitation rises again in the Cascades of Washington to more than 80 inches, but decreases in the Columbia Basin to 10 or 15 inches, while still another rise in the Bitterroot Mountains of Idaho brings the annual average up to more than 40 inches. These variations afford perhaps the most outstanding examples of topographic influence on vegetation to be found anywhere in the world. (Carter, 1951, p839)

Local variations may cause considerable differences in weather conditions within a few miles, especially during the fall and spring. This is important to the deer since snowfall and physiographic features apparently determine the winter game concentration areas. In addition, the type of snow and its depth determines the start of formation of large winter bands.

Precipitation

Generally precipitation increases from west to east and with an increase in elevation but topography plays a more important part in the geographical distribution of precipitation than does latitude. In northern Idaho, the winter precipitation is mostly snow which in ordinary seasons accumulates to great depths (Figures 3, 4, 5, 10 and 11). Dry seasons lasting three or four months characterize the summers and influence vegetal patterns. Over the study areas as a whole there is a noticeable lack of uniformity in precipitation pattern that seems to be directly related to altitude, prevailing wind, and proximity to the dry belt in eastern Washington where less than 15 inches of precipitation is recorded annually. Less than 100 miles eastward near the Montana border, the average annual precipitation of 48 inches is the highest recorded for Idaho. The average

annual precipitation over most of the section exceeds 24 inches (U.S. Dept. of Agric. Yearbook, 1941).

Shoshone County in the interior usually leads the state in total precipitation and recently several of its own all-time records were exceeded. From 1948-50, precipitation figures for several stations exceeded all former records.

Figure 3 illustrates the extreme departures from average weather conditions for Wallace that occurred during two consecutive winters, 1948-49 and 1949-50. Generally colder conditions and more precipitation occurred than the mean as indicated by 31 years of records preceding 1948.

Snowfall

Accumulated snow depths vary from year to year, place to place, and month to month. The snow falls usually from October through April with the heaviest snows recorded in January and February, and with maximum depths occurring in February in the intermountain area. Along the outer foothills there is seldom any accumulation, due to the periodic thaws removing the light annual snowfall. The interior elevations always have a considerable snow blanket even during mild winters.

Figure 5 shows the average monthly snowfall data for Coeur d'Alene and Wallace, emphasizing the difference between exterior and interior conditions and variation from month to month for Wallace. The monthly totals for the 1931-32 winter were not available, but 41 inches fell in Wallace, in the interior, during November and December of 1931. In the winter of 1948-49, heavy early snowfalls accumulated to unprecedented depths and few thaws occurred to settle the snow, until late February.

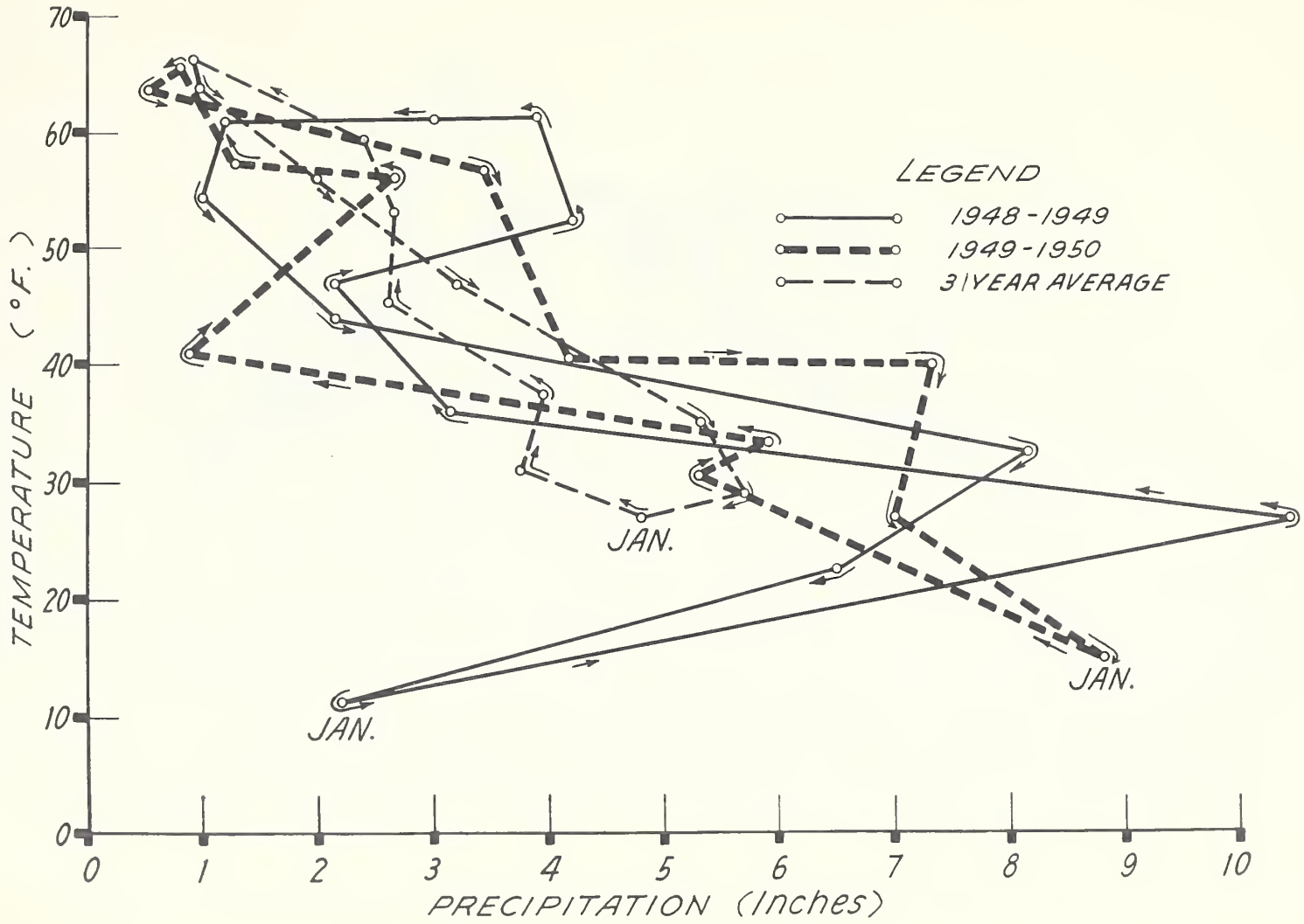


Fig.3. Climatographs for average and two severe winters for Wallace (Climat. Bull., Idaho)

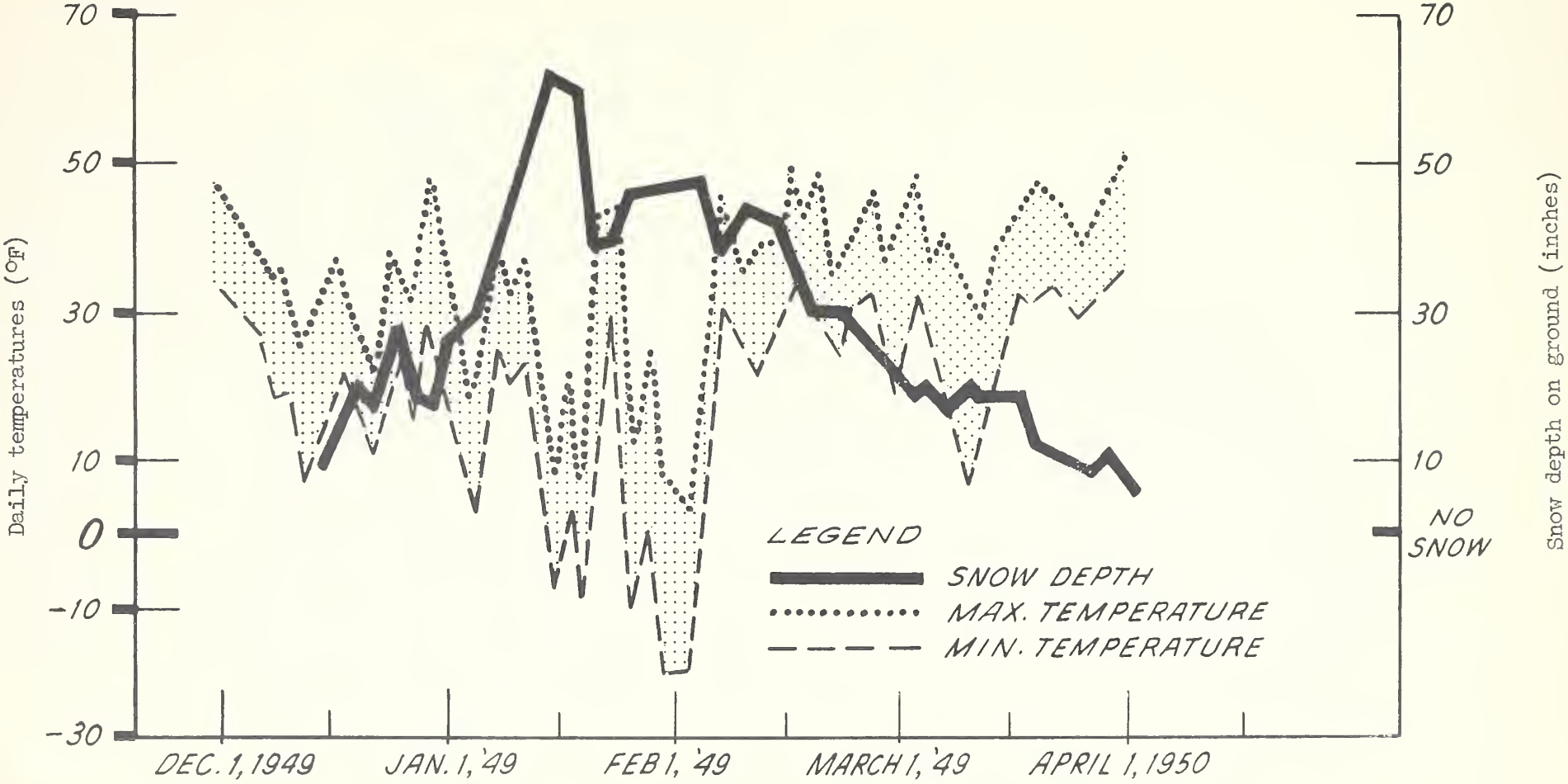


Fig. 4. Accumulated snow depths and daily temperature extremes for Wallace, 1949-50 (Climat. Bull., Idaho)

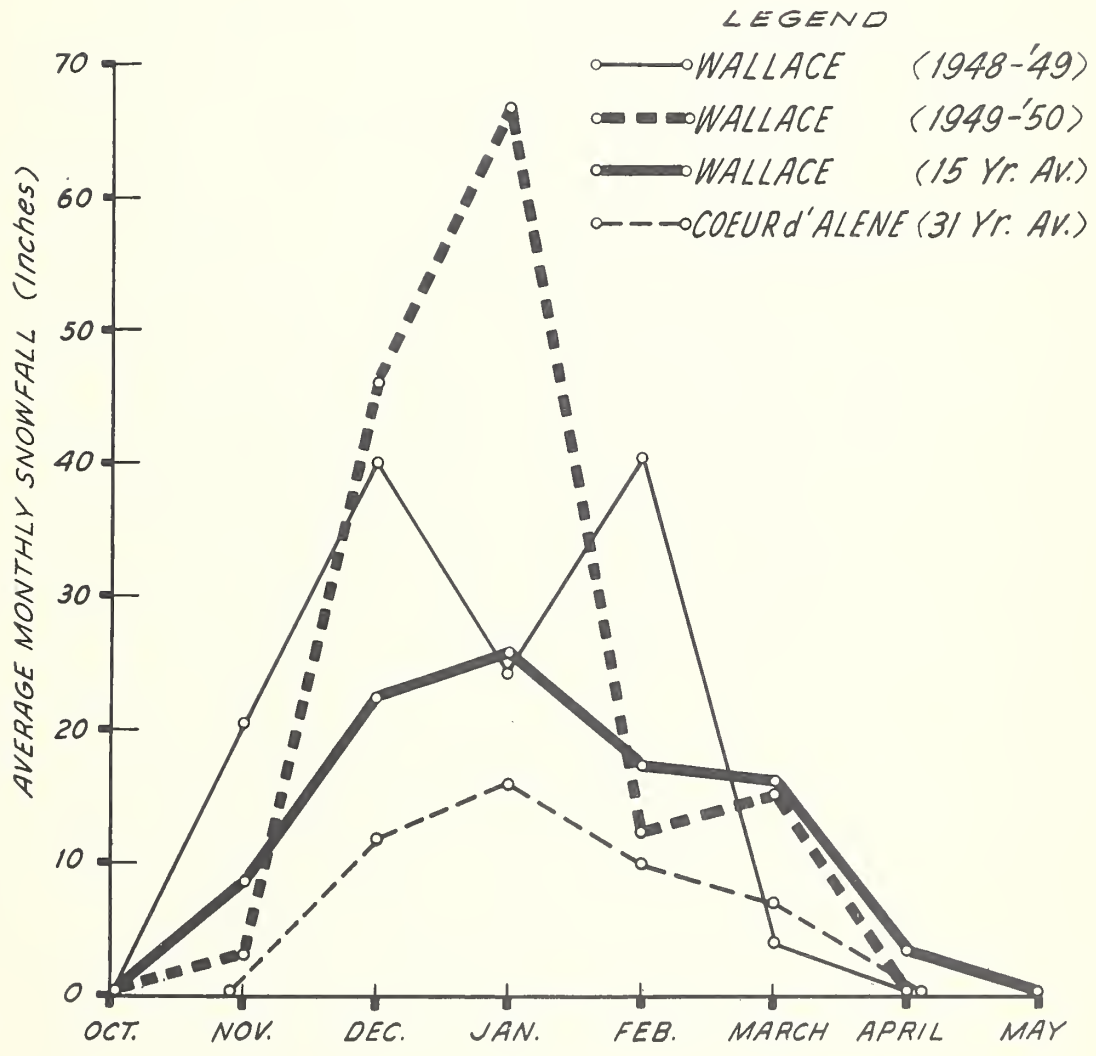


Fig. 5. Average monthly snowfall records for Coeur d'Alene and Wallace and two extremes for Wallace (Climat. Bull., Idaho)

The next winter, 1949-50, started out mild but late December snows and record snowfalls in January caused previous high records to be eclipsed when snow reached 5-foot depths on the upper river flats by January 20th. Alternate thaws and freezes crusted and settled the snow so that the deer could move on top. An extreme cold spell persisted for only one week in late January. Cold weather and deep snows persisted until late April and severe deer losses occurred. Snow depths were critical for deer for two full months near Wallace and for three to four months above Prichard.

Along the upper North Fork snow 30 inches deep was measured early in January and had not melted to 20 inches by the first of April in most places. Previously it had averaged 70 inches deep on those flats during the height of the 1931-32 winter when severe losses also occurred (Brown, 1936). The main wintering areas along the North Fork experience even deeper snows over longer periods so that any climatic feature true for the Wallace area is conservative for the interior of the forest north of Wallace.

Generally, winter weather conditions throughout the area are consistent although great extremes have been recorded. Burke averaged 207 inches of snowfall over a 30-year period but in 1949 and 1950 it had 400 inches and 335 inches, respectively, to eclipse all previous records. Coeur d'Alene averaged 51 inches of snow per year up to 1949 but received 94 and 76 inches during 1949 and 1950.

Temperature

Several large lakes on the western edge of the Forest and the low elevation (2,175 feet) combine to modify the foothill temperatures and snow conditions of the adjacent exterior area. Further east the higher

elevations and greater distance from the lakes result in heavier snow depths, although the temperatures are not greatly different.

Chinook winds exert a greater influence in reducing snow depths along the western and southwestern portions of the forest than they do in the interior area. Periodic snowfalls are removed by those warm winds and cumulative snow depths do not accurately depict total snowfall for the preceding time. Coeur d'Alene, on the exterior or western edge of the mountains, frequently influenced by warm western winds from over the lake, experiences these periodic thaws much oftener than the interior does. Over the more elevated portions of the study area as a whole the winters are rather long and the cold sometimes severe. In the lower valleys the winters are comparatively mild, more so than one would expect from the area's altitude and latitude. Occasional thaws do occur in the interior but the greater snowfall and cooler weather cause snows to accumulate to much greater depths and over longer periods than in the exterior region. Consequently the winter lasts one to two months longer in the interior, and snow exceeds the critical depths for deer for nearly twice as long as is true along the exterior western fringe.

Coeur d'Alene's record year for the exterior region snowfall (Figure 5) did not even approach the average figure for the interior Wallace area. This factor of heavy snowfall in the interior area combines with more even temperatures inland to slow down the thawing and settling process. The snow stays fluffy longer instead of crusting, and there is greater accumulations over longer periods, in contrast to the light snow of the exterior region, which soon melts off.

Forest Vegetation[1]

The mountainous slopes of this study area are clothed with a series of forest zones bearing definite altitudinal relationships to each other. This altitudinal variation in vegetation is controlled strongly by precipitation, which varies from 24 inches at Coeur d'Alene to 45 inches at Burke, and even more at higher elevations.

Daubenmire (1945) lists ten habitat zones of climax vegetation for the Rocky Mountains of which three are present in the study region in various seral stages (Figure 6). The zones are not rigidly defined belts in terms of elevation above sea level, although each zone reaches its best development within certain fairly definite limits of the altitude. Each zone characteristically sends long, pennant-shaped, and often discontinuous extensions down to considerably lower elevations along valleys and extending higher along the summits of dry ridges and the upper parts of south-facing slopes. Due to the resultant interfingering of the zones, their general altitudinal relationships are usually exactly reversed along the sides of ravines. For example, in the main body of the Douglas fir zone may be found the lower-most tips of extensions of the spruce-fir or arborvitae-hemlock zones following down the bottoms of the ravines, whereas on the summits of the adjacent ridges occur strips of the ponderosa pine type which are approaching their upward limits.

The lower and drier portions of this forest and some of the ridge tops belong in the Douglas fir zone. In the northern part of the state

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[1] Scientific names of plants and animals are given in the Appendix (A).

grand fir shares the climax with Douglas fir in the middle part of the zone. Following fire or logging, new habitats created by fire or logging may be invaded by ponderosa pine; and in addition, except along the lower exterior western edge, lodgepole pine, western larch, or western white pine may form temporary forests. When the Douglas fir first reinvades an area occupied by these seral trees, it tends to form stands so dense that the undergrowth is almost entirely excluded. As it matures and thins out, a profusion of herbs and shrubs, such as serviceberry, pin cherry, oceanspray, rose, ninebark, and snowberry invade the understory.

Upward onto the drier sites of the exterior portions of the study area, logging and fire have altered the Douglas fir stands, and ponderosa pine has come in as the dominant species. Idaho fescue and bluebunch wheatgrass are the dominant grasses. Ninebark, spiraea, rose and snowberry are prominent shrub species. After logging or fires these species, with redstem ceanothus, willow and oceanspray may form extensive heavy thickets, which form the major deer winter ranges in the exterior foothill areas.

Above the Douglas fir belt or in creek bottoms in northern Idaho. is the arborvitae-hemlock type. It is dominated by western arborvitae, known commonly as western red cedar, and western hemlock. Very little of this climax, once typical of the interior valleys remains. After fire or logging these sites are temporarily taken over by pure or mixed forests composed of western larch, lodgepole pine, Douglas fir, western white pine, grand fir, or occasionally black cottonwood, or ponderosa pine. Larch is especially fire resittant by virtue of its thick bark and consequently increases in relative importance on double and triple burns.

Stands of larch and lodgepole pine are frequently so open that they may be replaced by any of the other seral trees before the climax forest again takes possession of the ground. White pine and grand fir are the last of the seral species to disappear in the secondary sere which follows a fire, so that climax stands frequently contain a liberal sprinkling of decadent relics of these trees. In a number of areas either hemlock or the red cedar is poorly represented or absent in the climax. When the former is lacking, grand fir seems to approach a climax status. In the mountainous interior this type is the major wintering habitat for white-tailed deer.

The third and upper zone in this forest is the spruce-fir zone. It is characterized by subalpine fir and Engelmann spruce, the former species usually predominating. Temporary forests on burned habitats may be dominated by whitebark pine, western white pine, and grand fir, western larch, lodgepole pine, or Douglas fir. The undergrowth of climax forests is dominated variously by fool's huckleberry, true huckleberry and beargrass. This zone is of little or no importance as deer or elk winter ranges. It may be used quite extensively as summer range, where there is no apparent forage problem. Watershed protection is at present the principal value of the spruce-fir forest zone. The alpine zone is present only at the tops of the highest peaks in this Forest.

Techniques

Harvest

One of the most difficult phases of the study was to obtain accurate information on the harvest; i.e., the number of hunters, hunting pressures, species of game killed, and distribution of the kills, and the

fig. – 6 TYPE OF VEGETATIVE COVER, AND STUDY PLOT LOCATIONS

Source: U.S. FOREST SERVICE

effects of climatic conditions upon the kills. The dates and length of the seasons also exert an unknown effect upon the harvest, as do previous winter losses. Information was collected from three sources - volunteer locker checks, roving patrols and permanent checking stations.

Roving checks were made by conservation officers and the biologists who concentrated on the back roads and areas not covered by the permanent check stations. All hunters seen were interviewed. Licenses were initialed and hunters' comments regarding their efforts, success, localities hunted, and similar information were recorded. Technical data were taken when successful hunters were encountered and the data were incorporated into the check station totals.

The most valuable source of hunter information was collected by attendants operating game checking stations. Two full time stations were manned in 1949, four in 1950, and one in 1951, and two in 1952. In addition to the permanent stations, temporary weekend help was hired to help out on the other roads during the busy weekends of the deer and elk seasons in 1950 and 1952. Since the numerous access roads on the Forest make a complete check impossible, the station were located to contact a large sample of hunters. During the more recent seasons (1953-58) check stations were operated at Enaville and Dobson Pass during weekends only. These figures and estimates by local personnel are further supplemented by state-wide hunter postcard surveys (Table 12).

Carcass search

All known losses were recorded and the results summarized (Tables 14-17) by year and by species, sex, age, location and cause whenever these factors were known. These figures represent only a sample of the total loss.

In all cases where the femur was available, the bone marrow test (Cheatum, 1949) was employed to determine if starvation was a possible cause of loss. When the jaw was available the age was determined by reference to the known aging standards developed by Seringhaus (1949).

Censuses

Census sub-unit boundaries. The study area was divided into 11 management or census unit divisions of the whitetail winter range areas (Figure 8). There was some over-lapping use of the units, especially during severe winters when game would migrate down-river some distance to yarding areas. Complete checks over a short period of time on these questionable areas tended to eliminate duplications in count.

Type of count. The census methods to be used for determining white-tailed deer populations accurately in heavily timbered, mountainous terrain with highly variable wintering conditions are yet to be worked out. However, estimates of herd numbers may be made with fair reliability under certain conditions of temperature and snow.

The study began during the fall of 1949 and the ensuing winter was one of the severest ever experienced locally. Deer were confined to the narrow valley floors in the intermountain area for 12 to 14 weeks, so an attempt was made to obtain a total count by herd units. The vast acreages to be surveyed, deep snows hindering travel, and simultaneous occurrence of concentrations and die-offs all over the area made complete coverage difficult.

Actual counts were made of all game seen by location, date, sex, age class and species where possible. Estimates as to total numbers frequenting the area were based on the size and uniformity of the area,

track and bed counts, and supplemental observations on intensity of range use.

Snowshoe travel into snowbound areas and truck travel along plowed valley roads were the major means of covering white-tailed deer ranges during the three years the study was in progress, but only in 1949-50 did we get a good count. In February of 1950 deep snows forced game down along the lakeshores and many deer were counted from the mail boat travelling offshore. The estimates for each species by sub-units were not repeated after 1950 due to extremely mild weather and shortage of personnel.

Airplanes were used to find herds of elk and mule deer inaccessible from the valleys and to locate scattered signs of white-tailed deer on the exterior western portion of the study area where snow conditions were not severe. Airplane counts are not feasible for use on whitetails in this heavy cover. Table 3 is a summary of the 1949-51 Forest Service estimates by sub-units.

Time of count. The size of the study area made it impossible for two men to cover all 11 sub-units each month. The rapidly changing snow conditions also made a definite pattern of coverage an impossibility. The highest count obtained for a given unit over a period of time deemed short enough to rule out emigration or immigration was used for the final enumeration.

Recognizing sex and age differences at long distances or in heavy cover was often impractical so many animals were listed as unclassified. By February and March when animals could finally be seen, the buck deer had lost their antlers and the young of all species were large enough to be confused with the yearling classes; hence it was impossible to distinguish the three groups.

Counts were started in January 1950 after the first heavy snows and were repeated after each additional storm in an attempt to get the highest actual count for an area and to determine the down-river shifts that occurred as the winter progressed (Table 4). The 1951 and 1953 thaws and lack of subsequent storms prevented comparison of the counts. However, trips were made and number of game seen were tallied.

Census figures for five sub-units of white-tailed deer ranges in the interior region were established for three classes of winter severity (Table 2). Similar checks could be made each winter and the data from comparable winters used to establish a general trend in numbers stable, increasing, or decreasing. Deer in the upper North Fork above Lost Creek are subject to the least harassment since it is usually snowed in early and is a difficult area to hunt.

Range sampling techniques and procedures

The s mpling of range forage types was accomplished by three different methods: ocular reconnaissance, line intercepts and line points.

Ocular reconnaissance method. That part of the deer range inventoried was approximately the area used by white-tailed deer in the heavy-snow interior ranges during the severe winter of 1949-50.

The ranges were mapped into vegetation types and planimetered (Table 19). Plant species were listed and cover estimated at three heights: 0-2 feet, 2-7 feet, above 7 feet. A description of what constituted excellent, good, fair, or poor whitetail wintering areas was prepared, based largely on observations and experience gained the previous winter.

Line intercept method: Joseph Woolfolk (1952a) reviewed the project and suggested that the line intercept method (Canfield, 1941) be used on local browse ranges. His suggestions as to size of sample and other sampling problems were followed, with necessary modifications, as the work progressed.

Cooper (1959) gives these definitions of density and cover which I have attempted to follow through this paper. "Density is the number of individual plants per unit area. Cover is the area occupied by the plants." (See also Dorothy Brown,1954) Composition is the ratio of each plant to the others.

The Douglas fir-ninebark association, as described by Daubenmire (1952), was selected since it constituted the bulk of the white-tailed deer winter range on the exterior foothills and valleys being surveyed.

An attempt was made to select areas with different logging histories but which had never been burned and were nearly similar in elevation, aspect, slope and basic soil type. This was not always possible and differences in these factors may account for some of the variations encountered in the final results. The validity of assuming changes or trends by successive remeasurements has been commented on by Parker and Savage (1944):

> Provided the same lines were measured at intervals by the same individual, it appeared possible to depict accurately the trend of plant cover and composition during the course of a treatment.

Measurements: To measure samples in dense shrub and tree types on rough ground, a 100-foot steel surveyor's tape was selected for convenience and uniformity. The tape stretched along the ground marked the line of sampling unit. No attempt was made to correct for errors introduced by slope or obstructions. In browse surveys it seems practicable

to make measurements to the nearest inch rather than to hundredths of an inch as is commonly done on grassland surveys. A 6-foot type was used to make the individual measurements along the line.

The measurements of vegetation were made on the course of this line within its vertical plane and parallel to it. Each plant growing along the line was measured on the line intercept in a way that gave the numerical value of the ground that was completely occupied by the plants under or over the line to the height of seven feet. These measurements were recorded by plant species on a separate form for each sampling unit of 100 feet. Unit totals were easily obtained and the total units were combined on a single sheet to show the total species encountered, individual measurements, and totals by species and units. The amounts of each species are expressed in terms of percentage of ground cover and represents the relative amount of space completely covered with perennial vegetation. The line intercept measurements were recorded as length and interpreted as area (Brown, 1954).

Layering or over-lapping of vegetation creates a condition whereby it is possible to total more than 100 percent density along a line.

Since the object of this survey was to determine the relative quality and amount of browse species commonly available to game animals on winter ranges, no grasses or forbs were included in the species lists or measurements. Widespread and light use of the browse species by game animals would have necessitated an excessive number of samples to insure accuracy so forage use was not studied. Mature trees and browse crowns over seven feet high were included only in the narrative account in the field notes since they are not considered available forage.

Sample size and selection. The sampling unit is the 100-foot line and the sample is the number of lines or units measured. Preliminary statistical analysis indicated that thirty 100 foot-units per sample was well within the accuracy limits required.

To eliminate the bias of selection of site due to vegetative or topographic obstructions the plan for sampling was predetermined. A completely random sample was impossible if the study was to stay within a single association on comparable slopes and sites so a stratified sample was taken. The association, boundary of sampling sites, and the line locations were selected subject to the restrictions indicated below. complete randomness such as taking a due west course and measuring alternate 100-foot strips resulted in difficulties due to running out of the study area or having the lines fall in moist draws, or on north and east slopes where different conditions prevailed.

Selection of transects for measurement within the sampling area is made difficult due to the topographic variability and lack of uniformity in past land treatment. In nearly all cases where Douglas fir sites of known logging history had been selected, thirty 100-foot transects per site were established along contour lines. On some areas 15 or 20 lines were run when field checks indicated that there was very little variation in plant species encountered, or in the total intercept obtained. A total of two hundred-ninety 100-foot lines was measured in this phase of the survey.

Individual samples are described separately in the field notes and brief mention is made of the conditions that occurred in each area in the range section. It is assumed that the errors incidental to rough survey

methods are compensatory and will in no way affect the overall accuracy of the method.

Line point method. The line point method (Parker and Glendening, 1942; McCulloch, 1955; Taber, 1955) was selected in 1957 as a more convenient, faster, and equally accurate technique for surveying dense brush fields.

Brown (1954) wrote that the point is regarded as the smallest possible plot. The possibility of thousands of points (i.e. sampling units) being recorded makes the point an efficient unit. Usually the species are recorded at the point along with one parameter such as height. The change to line points necessitated checking against line intercept so the results could be compared. This has been done by Johnston (1956) and McCulloch (1955), and in a limited way in this study. In California, Heady et al.(1959), also demonstrated the superiority of transects over quadrats, and of line points over line intercepts with regard to ease and time required. With species of intermediate to high ground cover they state that line points will give means little different from line intercept at a reasonable sample size.

The current and recent cutting made it difficult to traverse the steep debris-littered sidehills, rendering impracticable the use of more precise systems of measurement.

Many techniques that work on flat pastures with a homogeneous plant cover are unsuited to these conditions. Shrubs also have a tendency to grow in clumps instead of being randomly distributed which increases the variability encountered with small samples. This made it necessary to stratify the sampling with lines laid out along the contour on south and west facing slopes. One hundred foot lines were laid out with 50 foot

intervals between the lines along the contour and altitudinally. Heights were estimated and species were recorded at each 1-foot mark along the tape with notations regarding the overstory. No attempt was made to sample all vegetation intensively and only woody shrubs and tree interceptions were recorded.

Plot locations in both interior and exterior study areas are shown in Figure 6 and listed in Tables 20 and 23. Two study areas in Shoshone County were logged one year previous to measurement and line points were measured there and in adjacent uncut control areas. One 7-year-old cut was measured to compare with the uncut control areas, and with the recent cuts.

Plots in Kootenai County were remeasured in 1957 using point plots and compared with the 1953 data on Douglas fir sites. Extreme changes in understory composition and density indicated either that sampling errors had been made or that rapid vegetative change had occurred. In 1959 the same plots were remeasured using the line intercept and line point systems simultaneously along eight 100-foot lines at Horse Ridge to evaluate any discrepancies due to changing the techniques. All data were examined statistically. (See Appendix B, Tables 25-36). This showed that the two techniques are yielding comparable data and the differences are due not to sampling error, but rather to the actual successional changes.

THE WHITE-TAILED DEER

Past History (Before 1949)

An old "History of North Idaho" (Henderson, 1903) contains reference to game in Kootenai County in generalized terms:

> Fish are plentiful and the wooded shores and hillsides afford excellent grouse and deer shooting. In the higher ranges of the mountains, bear, cougar, and caribou are found . . . Nowhere will be found a region more delightful and more satisfying from a sportsman's standpoint. From the wild range in the upper St. Joe region to the wilder confines of the Priest River reserve is one continuous game preserve.

The valleys and foothills of the exterior portion of the study area were the primitive hunting grounds of the Coeur d'Alene Indians and it is known that they seldom penetrated the forest interior. It is not known why they avoided the heavily forested area, whether it was superstitious fears, lack of game in the Forest, or an abundance of game near their tribal settlements. Old residents report that the Flathead Indians going to Cataldo Mission came into Idaho via Thompson Pass and down Prichard Creek because of the scarcity of game in Canyon Creek (Cooper Pass-Burke area). Prichard Creek is still one of the best remaining white-tailed deer areas left in the interior region. Mule deer, bear, elk, moose and mountain goat were also recorded in that area. Captain John Mullan (1863) stated in his Journals that he "sent hunting parties up the North Fork" (of the Coeur d'Alene River). David Thompson (White, 1950) referred to the brush antelope (whitetails) along the Clark Fork River near Pend Oreille Lake about 1810. Elk are seldom

mentioned in these early chronicles.

There is little chance of obtaining accurate reports regarding conditions prior to the past 80 years. The constant reference to the heavy timber cover "which blocks out the sun at high noon" and the reference to game along the lake and stream borders, however, is significant. In the light of present range use, it can be safely assumed that most of the game was probably found on the forest edge. The early references to game abundance were subject then, as now, to personal bias and knowledge, and a true picture of early conditions is difficult to reconstruct because of changes wrought by settlement, logging and fire.

Vern Perry, an old time resident of the Hayden Lake area, said in an interview in 1950:

> Deer were scarce in the valley from 1917 to 1933 but are common everywhere now. Everyone had a hound and they ran deer all year around. Constant killing, legally and illegally, kept the numbers down too. In the early days deer were killed for meat at the Fort and I recall seeing sleigh loads of venison hauled in to Coeur d'Alene prior to World War I. Early logging and the big fires opened up the sense timber and made conditions more favorable for the deer.

Forest rangers in their Annual Game Reports (U.S.F.S. files, 1921-58) have estimated the deer and elk populations on their districts at the end of each calendar year since 1916 (Table 1 and Figure7). The form and contents of the reports have varied as new information was needed or old data eliminated and, in 1949, the reports were shifted from the calendar year to the fiscal year which makes for better continuity in recognizing over-winter conditions and estimates. Up until 1940 they combined white-tailed deer and mule deer kill and other mortality estimates under one heading--deer. Individual rangers vary in their interest and skills and, as game conditions changed or personnel was shifted, addi-

tional sources for error were introduced. Nevertheless, these estimates are the best source of information available, and are a valuable supplement to the intensive studies made in 1935-37 and 1949-58.

For the purposes of range study it was possible to describe the interior mountainous ranges (Shoshone County) separately from the exterior foothill ranges (Kootenai and Bonner Counties). Winter loss as well as winter distribution of game is also easily determined for the two ranges but it is almost impossible to allocate total populations, productivity and harvest data to the separate areas, and it would be misleading to do so. In the following account there will be a separation of data by area and by game species where possible. The bulk of the data on mortality was gathered in the interior units where the severe winters concentrated the deer and increased the losses, and where the hunting is more difficult.

The northwest white-tailed deer is presently distributed (Kellogg, 1956) in the Rocky Mountain region from British Columbia (Babine Mountains) and western Alberta (Jasper), south through eastern Washington, eastern Oregon, Idaho (Snake River) and western Montana to western Wyoming (Valley, South Fork Shoshone River, Green River and Fort Bridger). This herd on the Coeur d'Alene is almost in the exact center of the known distribution and hence would not be likely to intergrade with O.v. leucurus on the west and O.v. dacotensis on the east. Throughout this report it will be referred to as white-tailed deer.

White-tailed deer have been found in the valleys and foothills of northern Idaho ever since white man first explored the area 150 years ago and are still common over most of the exterior foothill ranges. Large winter die-offs have been reported in 1927, 1932, 1949, and 1950, but the losses were soon recouped. This study began when the deer

population increase was apparently slowing down and leveling off after having reached maximum numbers. The clearing by logging and ranching has produced more white-tailed deer range than it has destroyed, so the largest herds are found in the larger valleys and along the foothills where most of this activity has occurred.

There are constant reports of other types of local deer (fantails, Columbia black-tails, mule deer-whitetail hybrids), none of which has been confirmed. Until more definite evidence has been produced, it seems safe to state that only two sub-species of deer inhabit this section of northern Idaho, the northwest white-tailed deer and the Rocky Mountain mule deer. The latter deer became more numerous following the great fires of 1910, 1919, 1926 and 1931.

The Study Period (1949-1959)

An appraisal of a deer herd usually involves determination of herd size, composition, vigor, productivity and normal losses. Removals from the herd in the form of legal harvest and all other sources of losses also must then be determined. Management recommendations designed to balance the herd with available winter forage and to reduce the non-harvest losses are the final phase.

This section deals with a discussion of numbers, distribution, productivity and mortality of the white-tailed deer during the ten year study period. From 1949 to 1954 detailed studies were in progress and from 1954 to 1959 records of cooperators are used to complete the report.

Numbers

White-tailed deer are among the most difficult of all the important big game animals to census in the wild. Their small size, secretive habits, and preference for heavy cover all combine to make the use of

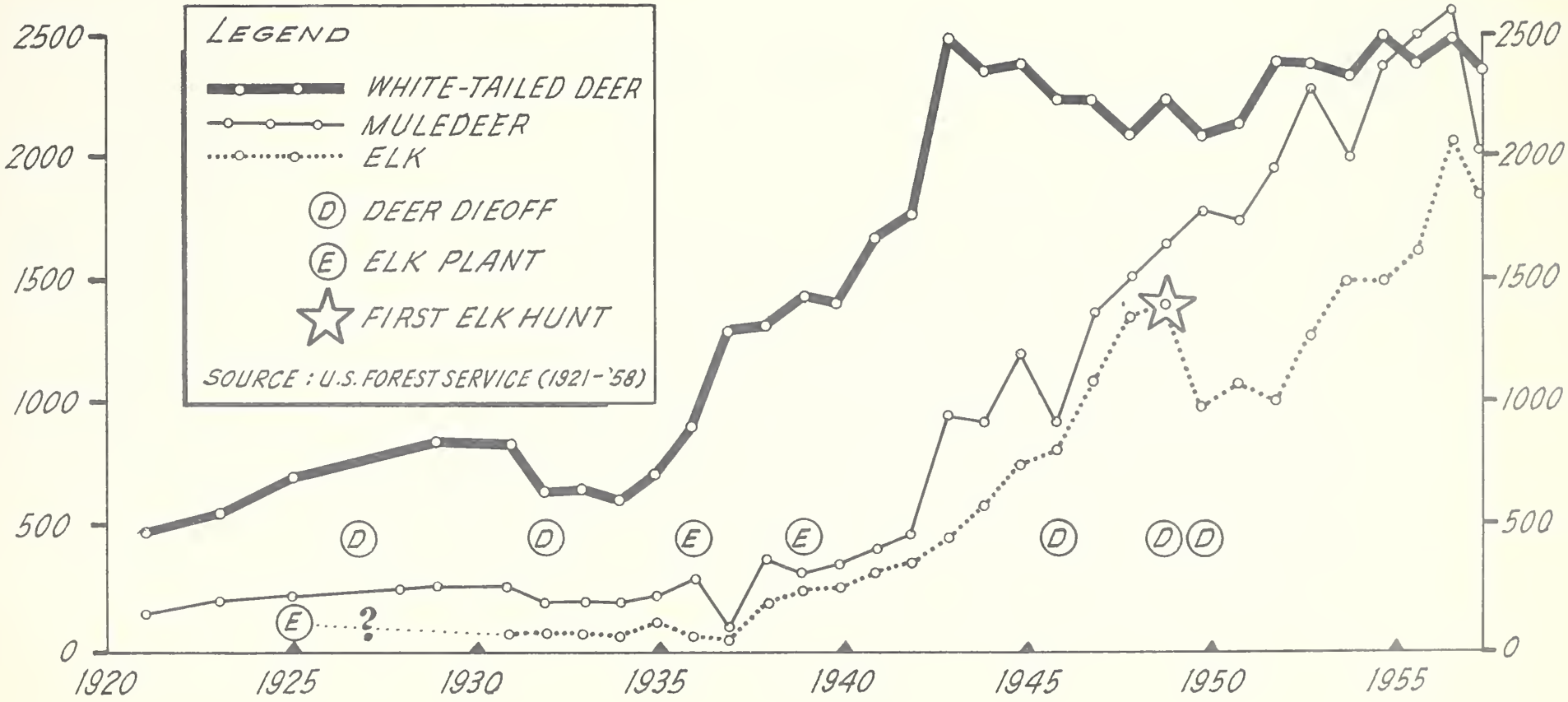

Fig. 7. Estimates of game populations on Coeur d'Alene National Forest, 1920-1958

Table 1. Estimated populations, harvests, and other losses of white-tailed deer for the Coeur d'Alene National Forest, 1921-58

Year	Estimated whitetails	Estimated whitetail harvest	Estimated deer[a] losses	Remarks[b]
1958	2320	490	35	Very mild winter.
1957	2500	390	35	Snow depth near average.
1956	2450	280	40	Winter about normal.
1955	2500	200	40	Very mild winter.
1954	2300	250	50	Above average snow; crusted. Poaching heavy.
1953	2400	230	60	Exceptionally mild winter.
1952	2400	230	100	Extended hunting season. Poaching a year-round problem.
1951	2150	110	100	Normal winter, six weeks concentration upriver; poaching major drain.
1950	2100	250	600	Heavy snowfall, abnormal losses of deer.
1949	2250	100	500	Heavy snowfall, abnormal losses of deer after 2 easy winters.
1948	2100	450	370	Very open winter. Heavy fall snows. 6700 hunters.
1947	2250	350	315	Open, mild winter. 4300 hunters. White-tail numbers up.

[a] Deer losses were seldom estimated by species but most losses are of white-tailed deer.

[b] Source - U. S. F. S. Coeur d'Alene National Forest files, 1921-58, Annual Ranger Estimates.

Table 1. Continued

Year	Estimated whitetails	Estimated whitetail harvest	Estimated deer losses	Remarks
1946	2250	530	270	Winter abnormally severe, 5-6' of snow on up-river flats. Poor harvest in fall of 1945 followed by heavy poaching.
1945	2390	360	148	Winter not severe. 4850 hunters, 67 predator kills, rest poached.
1944	2345	218	125	Mild winter after extended hunting season 40 predator kills.
1943	2500	135	100	Tough winter after extended season but few losses of deer.
1942	1780	295	-	Mild winter. Fall snows upped kill.
1941	1680	145	-	Mild winter.
1940	1410	200	-	No fall snow.
1939	1450	200[c]	55[d]	3450 hunters.
1938	1330	300	55	Heavy fall kill; little migration.
1937	1300	150	50	Recovering from 1932 die-off.
1936	908	150	-	Apparent increase due to severe weather and less migration.

[c]Deer harvest estimates were for both species of deer from 1921-39. The figures given here are my approximations of the kill of whitetails based on their total estimates.
[d]All losses from 1929 to 1939 were listed as predator kills, except for the 1932 die-off.

Table 1. Continued

Year	Estimated whitetails	Estimated whitetail harvest	Estimated deer losses	Remarks
1935	731	150	40	1515 hunters - season should be closed.
1934	634	150	40	--
1933	686	100	40	--
1932	656	100	40 600 winter kill	Big spring die-off after tough winter.
1931	850	125	40	585 hunters. Forest fires.
1930	850	-	Heavy	Hard to hunt; deer and hunters scarce.
1929	859	40	55	Easy winter; 323 hunters.
1928	822	50	-	Easy winter; 272 hunters.
1927	-	-	-	--
1926	-	-	-	Large forest fires.
1925	710	-	-	247 hunters.
1924	-	-	-	Game decreasing due to pressure in Coeur d'Alene area.
1923	565	150	-	--
1922	-	-	-	--
1921	490	125	-	-- (Large fires along North Fork in 1919)

most census methods impractical. Following two consecutive severe die-offs in winter (1948-50) the populations probably reached a very low point in the interior portion of the study area. Two of the major sources of information regarding deer productivity--census and harvest data, were thus limited.

The narrow, steep-walled ravines, heavy timber and brush cover, and low density of deer over large acreages, even in severe winters, leads one to the inevitable conclusion that a total count per unit area by large crews during severe winters is the only practical census method available on which to base population estimates and trends.

The Forest Service estimates (U.S. Forest Service, 1920-1958) over the past 38 years (Table 1 and 3 and Figure 7) have been subject to many variables that affect the accuracy of the figures, yet the inescapable conclusion is that there are more deer and elk on the forest (in 1960) than formerly. Occasional winter losses and heavy harvests flatten out the curve of rising populations, but within four or five years the numbers are regained.

It seems probable that the disturbances created by extensive logging prior to 1920 and the great fires of 1910 and 1919 created favorable conditions for game. Additional fires in 1926 and 1931 and continuous logging have provided mixed aged stands of brush and cover over much of the area used by game in winter. All of the changes have not been favorable. The 1931 Magee fire denuded thousands of acres of river bottom land and hence made it untenable for whitetails. Mule deer increased reapidly in the vast, rocky brushfields in the next ten years and this can be partly attributed to the habitat changes wrought by that fire.

White-tailed deer apparently increased slowly until the severe die-off in the spring of 1932 (Table 3). By 1937 it was estimated that they had regained their numbers and were increasing rapidly. Illegal gun pressure during the 1930's and the war years that followed did not reduce the numbers appreciably. The estimates for the post-war years, with 300 to 400 percent more hunters than frequented the area ten years previously, indicated that numbers were being depressed. Heavy hunter kills from 1945 to 1948 along with three severe winters (1946, 1949, 1950) reduced estimated white-tailed deer populations as much as 35 percent in one year. The severe winter losses made hunting even more difficult and the subsequent light take, followed by a series of average or mild winters, allowed a noticeable increase in numbers.

Table 2. Summary of white-tailed deer counts on five range sub-units in Shoshone County, Idaho, during each of three winters

Area Sub-Unit No.	Kind of Winter	Little N. Fk. #6	Main N. Fk. #7	Upper N. Fk. #9	Millers's #11	Prichard #8
Year						
1949-50	severe	167	100	187	100	250
1950-51	average	25	10	84	49	42
1952-53	mild	5	3	20	5	12

Table 2 summarized the winter counts for white-tailed deer on five sub-units for three winters of varying severity. There is a very definite decrease in numbers for each unit paralleling the decrease in severity of winter. Heavy losses during the winters of 1949 and 1950 undoubtedly affected the 1950-51 census but the milder winter also exerted an unknown effect on numbers seen. This was very obvious in 1952-53 when very few deer were seen during the winter (Table 2) and large numbers were reported for the same areas during the spring.

Estimates of 2800 white-tailed deer by project biologists in 1951 were 32 percent higher than the Forest Service estimate of 2150. Recent estimates place the white-tailed deer populations at 2320 for 1958, following high estimates of 2500 in 1955 and 1957 (Roger, 1959).

Any error in estimating game numbers will probably be on the conservative side if experience elsewhere holds true here. Longhurst et al.,(1952), commenting on the reliability of estimates stated:

> For the few herds that had been censused, the determined populations indicated that previous estimates not based on census work were too conservative. Thus the Forest Service estimates of deer numbers, taken annually since 1922, were probably far below actual numbers, though they had great value in depicting trends.

A word of caution regarding the feeling that all estimates are too low has been voiced recently by Hickie (1957) who has shown that where estimates are based on steady percentage increases they can be too high. The growth of any animal population usually follows the logistic formula so the rate of increase declines after herds have increased to the point where limiting factors are more influential.

The analysis of the dynamics of populations of big game has been aided by the pioneer work of Kelker (1944, 1947, 1952) and the series of variations were followed by Robinette (1949), Lauckhart (1950), and Selleck and Hart (1957). This system of analysis makes use of the ratios which are derived from herd composition counts of the wild population before and after the hunting season, and the sex and age ratios in the kill. By use of these data it is possible to either make estimates of the total population or the proportion taken during the hunting season when the field data have been tested for reliability and found adequate.

An effort to apply these techniques to the present study was made,

and material taken at checking stations provided a useful cross-section of the kill. However, every effort to obtain reliable herd composition counts, either before or after the hunting season failed, because of the virtual impossibility of observing or classifying the deer, hence, this system was not used in appraising the size of the deer herd on the study area.

Distribution

During range and census surveys deer and elk were seen to occupy definite habitat types. Some areas seemingly suitable for game use were unpopulated (Bear Creek, Camp Nowhere). Each species exhibited a variation in distribution during different seasons, and over the period of years since the study was inaugurated, there was increasing evidence that some herds were still expanding their range. The seasonal distribution is considered below.

Summer and fall distribution. Whitetails have free and unrestricted use of the whole forest during the summer and fall and may be seen on ridge tops or valley bottoms. The majority of the whitetails, especially the does and fawns, stay fairly low. Generally their summer range is just a slight expansion of their winter range. Tracks can be observed along the creeks and river sand-bars all summer and deer can be seen at night crossing the roads or feeding in meadows. During the heat of the day, and as the summer advances, there is a gradual upward movement to wind-swept knobs, but seldom to high elevations. The bucks seem to prefer less brushy areas when their antlers are in the velvet. No attempt was made to locate whitetails on summer range because of the conflict with other duties.

Whitetails were taken by hunters along the highest ridge tops and

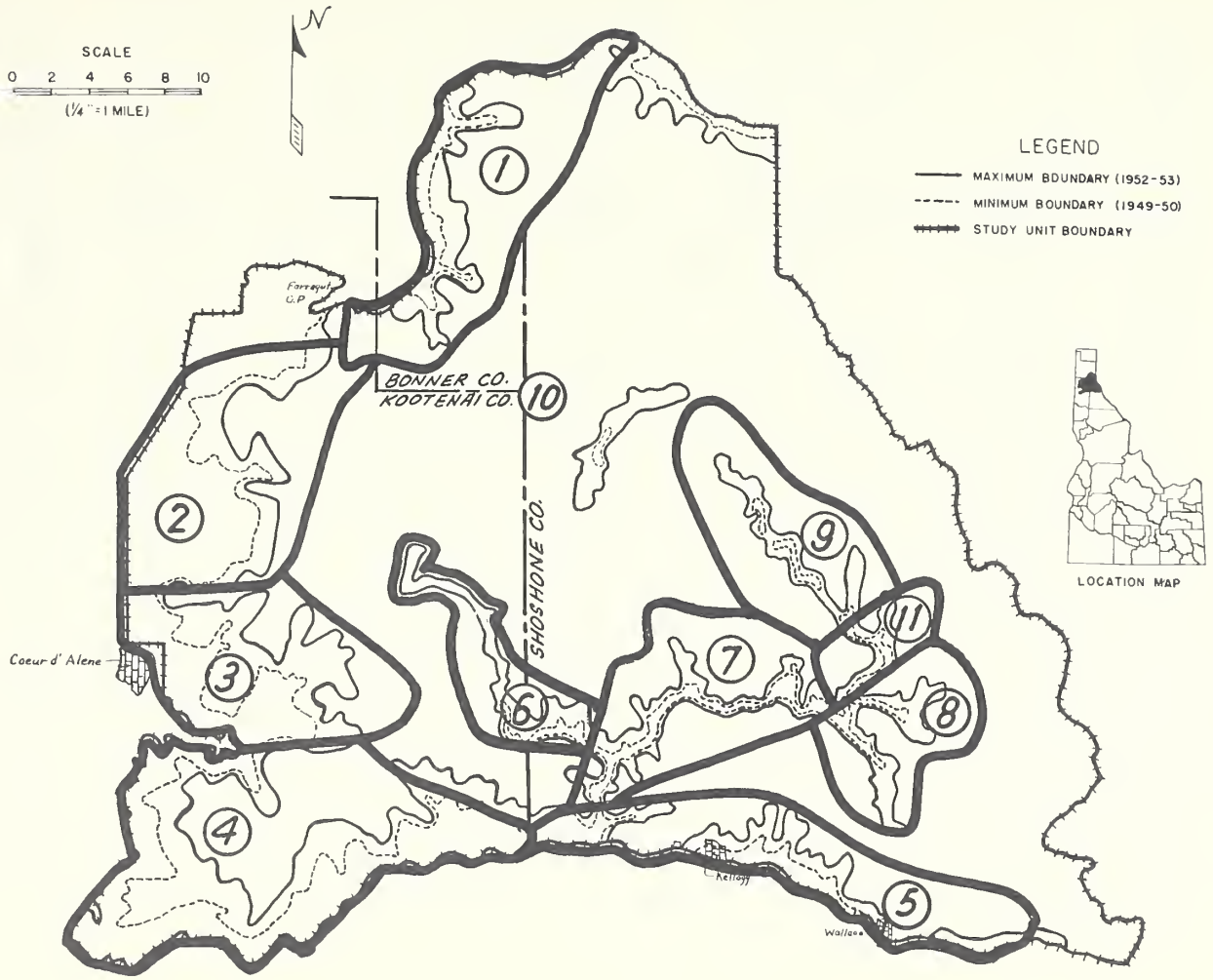

Fig. 8. White-tailed deer winter ranges and study sub-units

muledeer in open fields along the rivers, so generalizations about habitat preference are generally unreliable during the hunting season. The distance from ridge top to valley floor is not extreme, seldom exceeding 2,000 feet, and would not deter daily movement of hunted animals.

Table 3. Winter deer and elk estimates for the Coeur d'Alene National Forest; 1949-51 (U.S. Forest Service estimates)

Sub-unit No.	White-tailed deer 1949-50	White-tailed deer 1950-51	Mule deer 1949-50	Mule deer 1950-51	Elk 1949-50	Elk 1950-51
Kootenai County						
#1 Granite Creek	267	190	292	210	36	42
#2 Hayden Lake	955	800	99	100	26	40
#3 Coeur d'Alene Wolf Lodge	293	482	6	60	6	-
#4 Harrison Triangle	475	610	100	110	6	6
Shoshone County						
#5 So. Fk. Coeur d'Alene	228	140	97	95	187	140.
#6 Little N. Fork	250	100	0	20	6	12
#7 Main River (Enaville-Brown Gulch)	202	147	77	135	256	190
#8 Prichard-Beaver Junction	260	136	155	125	54	50
#9 Main River-Lost Creek to Magee	251	189	65	70	65	95
#10 Balance of Forest	12	105	52	85	17	15
#11 Main River-Prichard to Lost Creek	140	95	60	40	8	-
Totals	3333	2994	1003	1050	667	590

Winter and spring distribution. Major white-tailed deer wintering areas in the interior areas in the past have been the Little North Fork (lower ten miles); main river from Enaville to McPherson's Ranch, and the Magee country; Prichard, Beaver, Lost, Big and Steamboat Creeks, and tributary drainages to the South Fork, north of Highway U. S. 10. Now

the major interior-wintering areas are portions of the Little North Fork, the lower end of Prichard and Beaver Creeks, and scattered bands along the main river (Flat Creek, Long Pool, Devil's Elbow, Shoshone Ranger Station flats, Clee Creek, and Miller's Ranch area. (See Figure 8 and Table 3).

All big game animals seen were recorded and tallies made for census, distribution, food habits and productivity studies. Many observations were not complete enough to give the desired information, but for knowledge of distribution, the merest sight records or sign sufficed. The greatest limitation to obtaining precise distribution data was the inability of the two field men to cover widely scattered ranges thoroughly in a short season. Constantly fluctuating conditions of snow depths, thaws, freezes, and other physical factors added to changes in game habits as the season progressed, made continuity and completeness difficult.

Since much of the bottom land has not only been changed by logging and fires but also by clearing for ranches, the total acreage available and suitable to deer is being constantly diminished. Along the lower North Fork where snow depths are slightly more favorable than up-stream, roads have been constructed along both sides of the river and are kept open all year around. This has reduced available acreage also, plus contributing to the deer shortage through harassment, accessibility to poachers, and as an aid to legal hunting.

The creek or river bottom is the range relied upon during critical winters. During milder weather or more favorable snow conditions, whitetails move up on the sidehills to feed during the day but usually return

to the bottoms to bed down at night. At certain periods this may be reversed, as when the snow remains deeper in the creek bottoms than on the sidehills. Then the deer will bed down on the sidehills at night and during the day, moving down to the bottoms in early morning and late evening to feed.

The sidehills are often warmer than the valley bottoms due to cold air drainage and exposure to the sun. Heavy timber cover and broken topography moderate the force of the winds and blizzards are rare in the interior. When the deer do bed down in the river bottoms they seem to prefer the islands in the river, perhaps because of the protection from coyotes as well as for the feed available. They have also been observed resting during the day under heavy hemlock stands where the snow depths are relatively shallow due to crown interception and feed is non-existent. The frozen rivers are used as travel routes for snow depths are usually less there and new sources of forage overhanging the river become available.

Heavy snows bring about a gradual migration to the valley bottoms and down-river in extreme winters. However the usual pattern, even for a deep snow area, is for the deer to remain fairly close to their summer range. The secretive habits of the whitetail and the heavy cover on steep slopes makes them difficult to observe, hence the prevalent idea of shortages of game. A slight dispersal of whitetails from areas of concentration is nearly as effective as spreading them out over the whole forest as far as seeing them is concerned (Table 4). The periods of concentration after severe storms are usually very short so that observations must be made over the whole area almost simultaneously, at or near the peak of concentration, if accurate checks are to be made.

Table 4. Total numbers of all big game species tallied during each of three winter counts on the Coeur d'Alene National Forest

Year	Kind of winter	White-tailed deer	Mule deer	Elk
1949-50	severe	1457	296	296
1950-51	average	284	76	101
1952-53	mild	119	38	86

Traditionally, white-tailed deer inhabit the river and creek bottoms and lower slopes where forage is available. The heavy snows and cold winds in early winter make travel difficult and bury feed. The white-tailed deer then move to the wintering grounds, apparently mainly for shelter. Thus winter distribution may be determined by some factor other than food availability. Cheatum (1951b) wrote, "It has been shown that desire for protection from exposure may overcome desire for food and explains the supposedly suicidal habit of returning year after year to over-browsed feed lots." Webb (1948) concluded that cover is the factor which determines the areas in which deer concentrate. Murie (1951) also quotes a reference that seems to bear out this peculiar habit:

> Furthermore, game are perhaps like human beings in the matter of being conservative about their habits. They are in a district because their ancestors were there before them. They will not move until starvation and great danger threaten their very existence. They will remain in a poor environment which used to be good simply because circumstances or sheer inertia prevent them from seeking better surroundings. Sometimes they may even stick to one district until extermination overtakes them. (J. Wong Quincey, Chinese Hunter.)

White-tailed deer in this area seem to prefer at least 50 percent canopy cover. Solid low brush fields do not attract them and only the edges of large openings are used.

An unusual feature of the whitetails in this study area is the migration from the north half of the interior of the forest northward across the Bunko Road and down into winter ranges along Lake Pend Orielle on the Gold Creek and Granite Creek. The date and extent of the migration is determined largely by the severity of the winter. In 1936, E.R.A. workers patrolling the Bunko Divide, tallied 383 deer from November 1 to December 10 crossing over into the winter yards. The return movement began after April 15, 1937. Both species of deer and elk are known to participate in this movement and it may account for some of the apparent discrepancies in annual over-wintering estimates by the Forest Service. Some herds of mule deer apparently prefer to remain where they are despite adverse wintering conditions. Brown (1936) states, "Mule deer failed to move down to creek bottoms at any time. The band of mule deer on the East Fork of the Coeur d'Alene River remained on a fairly high north slope in 50-70 inches of snow during the month of January."

In Kootenai County, in the exterior region, white-tailed deer are commonly found along the lodgepole pine flats on the south and west slopes of the western foothills. Creek bottoms and lake shores are also utilized but not as extensively as the rolling foothills. There are no blanks in their occupation of the ranges from Farragut south to Harrison and eastward up the river valley.

Effects of snow on distribution. Throughout the entire study period, observations were made of the effect of snow on the distribution of white-tailed deer. Other factors combine to influence their choice of wintering areas but crusted or deep snows buries feed and hampers travel. Forest Service workers (Brown, 1936) during the 1935-37 studies described

their observations as follows:

> The heavy loss of deer during the spring of 1932 came on the heels of a long spell, practically all winter, of heavy snow storms. The snow was not crusted and it was deep (70 inches on flats). Deer herds concentrated along river bottoms close to willow flats.
>
> Snow loosened and game moved easily until February 6, 1937, when a crust formed and game yarded. (Thirty inch average depth on winter range.) They moved out of the creek bottoms onto the south slopes about March 11th, after 35 days of intermittently crusted snow. . . Last fall snows coming suddenly isolated small bands of deer during the hunting season. There was very little migration over onto the Kaniksu side due to early favorable snow conditions.
>
> During 1937-1938 there was very little snow early in the season. The annual migration to the Kaniksu did not take place as was seen in March when heavy, late snows showed a large increase in deer on the Magee District.
>
> The 1942-1943 winter was more severe than average. Forest Service employees found deer yarded up between Flat Creek and Nowhere along the main North Fork.
>
> Game was up to 5,000 feet on the Kingston District in December, 1944, due to lack of snow.

Effects of topography on distribution. White-tailed deer do not frequent the long, steep slopes during the winter. Both deer and elk frequent south slopes in mid-winter where the warming rays of the sun are welcome to the animals, and the snow recedes early, releasing food supplies. Elk are far better suited to mountainous terrain than the whitetail, and winter on the open ridges near timber or move there as soon in the spring as possible. An overlay of white-tailed deer winter ranges on a topographic map shows close agreement between deer distribution and the 2,500 feet elevation level on the southern and western forest margins. In the forest interior, whitetails generally remain below the 2,300 foot level.

Effects of land use on distribution. Preliminary observations and historical records indicate several major influences affecting the distribution of deer and elk over the Coeur d'Alene Forest, both in space and in time (Figure 6). Logging and ranching have opened up much of the timber cover, thereby increasing suitable whitetail range. Where too much cover has been removed and where whitetail range has been destroyed by ranchers, a reduction in whitetail habitat has occurred. The large fire that swept the Magee area in 1931 changed it from good whitetail range to mule deer range. As plant succession progresses and the vast brushfields give way to the uneven-aged stands of conifers, it is reasonable to expect that the region will once more become good whitetail range and mule deer numbers will decline. Evidence of this shift in species was noticeable by 1954 along Tepee Creek at Magee.

Pollution of streams by mining wastes and pollution of the air with fumes from nearby smelters may have some local effect upon the distribution of game due to changes brought about in the composition and density of vegetative cover.

Whitetails have shown a tendency to overcome their fear of man and attempt to exist close to habitation to satisfy their habitual needs for certain ranges.

Summary

An apparent low deer density after two heavy die-offs in the interior (Shoshone County) and the secretive habits of whitetails in heavy cover made accurate censusing by belt transects or drives almost a physical impossibility. An estimate based on total counts during severe winter concentrations was believed to be the best technique for basing our population figures.

U.S. Forest Service Photo

Fig. 9. Northwest white-tailed deer in typical habitat on the Coeur d'Alene National Forest. During ordinary winters, cover and forage are adequate for survival and herds have increased steadily since 1920.

Fig. 10. Deep snows bury forage, hamper travel and predispose heavy losses of white-tailed deer.

Fig. 11. Elk accept a wider range of forage, terrain and snow conditions than do the smaller deer and suffer fewer losses to all causes.

Previous unexplained increases have been attributed to early fall snows which drive deer out into the open and thereby increase the estimates. Or, it may be partly psychological--after the previous two severe winters when the die-offs were feared to have decimated the herds, the appearance of deer in even modest number is viewed with relief and optimism. The apparent demand by white-tailed deer for the correct combination of habitat requirements, is in effect, a self-imposed set of limiting factors which, coupled with unfavorable vegetational succession, materially reduces available winter range.

Productivity

The game manager who attempts to achieve maximum deer production soon finds that many of the basic questions relating to productivity remain unanswered. Specific information is needed regarding the sex and age ratios, number of breeding does, number of fawns normally produced per doe, the percentage of unbred does, and the relationship of the present population to its winter food supply. In addition to the unknown physiological factors affecting reproductive potential, there are the only partially known conditions of winter loss and fall harvest removals. Even these conditions are difficult to assess and additional losses to predators or to climatic conditions further lessen the rate of increase.

Robinette (1956) in writing on deer productivity commented:

> ...Only rarely does the net productivity or net increase (actual yearly rate of increase less non-hunting mortality) in the wild ever approach the potential productivity. The white-tailed deer of the George Reserve in Michigan achieved a 65 percent rate of increase during its initial six years (Kelker, 1947).

Generally white-tailed deer have a high reproductive potential, approaching nearly two fawns per adult doe. However, extreme conditions

of adversity, such as occur on over-populated ranges, limit population growth or cause its decline.

Severinghaus and Cheatum (1956, in Taylor) have presented life equations for white-tailed deer in several northern ranges in which the reproductive rate varies with range and herd condition. On the better ranges, adult does produced 1.90 - 2.00 fawns per doe; on poorer ranges fertility declined to 0.73, with an average probably near one fawn per doe, or half the potential.

Possible sources of productivity data may be obtained from total counts and trend counts with known-age and sex groups classified. Harvest records plus other mortality records, along with fetus and corpus luteum counts are additional clues. Unfortunately the low densities of whitetails on the study area does not provide good opportunities for making numerous and precise observations. Much of the material gathered on these animals is fragmentary. All available data have been examined for clues as to the productiveness of the game animals that were observed during the study period.

However, field records were kept of all game observations--sex, species, age, animal condition and behavior, and distribution by season and range area. The large numbers of dead animals listed as unknown or unclassified throughout this report represent carcasses destroyed by scavengers or by deterioration, incomplete observations by cooperators, and inconclusive personal observations.

Harvest ratios

The newness of the research project and the extensiveness of the assignment prompted us to limit our collection of kill data to a tally of game taken by sex and species. Hunters were encouraged to submit

Table 5. Summary of known white-tailed deer harvests: 1949-50-52

	Adults		Fawns		Age unclassified			
	Bucks	Does	Males	Females	Male	Female	Unclass.	Total
1949:								
Two check stations	7	10	2	5	0	0	0	24
Other sources	2	2	0	0	8	16	4	32
Sub-total	9	12	2	5	8	16	4	56
Percentage	16.1%	21.4%	3.6%	8.9%	14.3%	28.5%	7.2%	100.1%
1950:								
Four check stations	24	19	3	9	0	0	1	56
Other sources	22	13	2	1	0	0	7	45
Sub-total	46	32	5	10	0	0	8	101
Percentage	45.5%	31.7%	5.0%	9.0%	0	0	7.9%	100.0%
1952:								
Two check stations	15	25	2	4	0	0	0	46
Other sources	42	30	8	6	0	0	11	97
Sub-total	57	55	10	10	0	0	11	143
Percentage	39.9%	38.5%	7.0%	7.0%	0	0	7.7%	100.1%
TOTAL (3 years)	112	99	17	25	8	16	23	300
Percent of total	37.3%	33.0%	5.7%	8.3%	2.7%	5.3%	7.7%	100.0%

Table 6. Summary by years of indicated ratios from harvest records of white-tailed deer: 1949-50-52 (from Table 5)

	1949	1950	1952	Weighted average
Adult : fawn ratio	100 : 33.3	100 : 19.2	100 : 17.9	100 : 19.9
Size of sample	21 : 7	78 : 15	112 : 20	211 : 42
Doe : fawn ratio	100 : 58.3	100 : 46.9	100 : 36.3	100 : 42.4
Size of sample	12 : 7	32 : 15	55 : 20	99 : 42
Percent fawns	25.0%	16.1%	15.2%	17.5%
Buck : doe ratio	75 : 100	144 : 100	104 : 100	113 : 100
Size of sample	9 : 12	46 : 32	57 : 55	112 : 99
Fawn male : fawn female ratio	40 : 100	50 : 100	100 : 100	68 : 100
Size of sample	2 : 5	5 : 10	10 : 10	17 : 25
Herd male : female ratio	58 : 100	121 : 100	103 : 100	98 : 100
Size of sample	19 : 33	51 : 42	67 : 65	137 : 140

Table 7. Summary of age classes of deer as represented in a voluntary jaw collection, fall, 1952

Year born	Age	White-tailed deer		Mule deer	
		No.	Percent	No.	Percent
1952	fawn	6	20	3	7
1951	$1\frac{1}{2}$	13	44	13	31
1950	$2\frac{1}{2}$	2	7	12	29
1949	$3\frac{1}{2}$	1	3	3	7
1948	$4\frac{1}{2}$	0	0	0	0
1947	$5\frac{1}{2}$	1	3	3	7
1946	$6\frac{1}{2}$	1	3	0	0
1945	$7\frac{1}{2}$	0	0	0	0
1944	$8\frac{1}{2}$	11	3	3	7
1943	$9\frac{1}{2}$	0	0	0	0
1942	$10\frac{1}{2}$ and over	5	17	5	12
Total		30	100%	42	100%

deer and elk jaws for aging and at the checking stations, weights and body measurements were taken with the hunter's permission. Quantitative data on whitetails, the major species to be investigated, was difficult to get due to the low kill. Station attendants were often unable to get all the required information about the few deer that were checked out due to hunter reluctance to cooperate.

A summary of the kill for three seasons is found in Table 5, and of the indicated rations in the kill in Table 6. The heavy winter losses in 1949 and 1950 were partially reflected in the take (Table 5); only 24 whitetails were checked through two full-time stations in 1949, and 56 through four stations the following year. In 1952, 46 animals were tallied at two stations. This gives a total of only 126 white-tailed deer checked at stations during three seasons, each of which varied from four to eight weeks in duration.

A total of 300 whitetails were checked in three seasons; 126 at the stations, and 174 additional by roving patrols and by volunteer effort. Of this number 112 bucks, 99 does, 17 buck fawns and 25 doe fawns (Table 5) were fully classified by age and sex. Eight males and 16 females were not classified by age, and 23 whitetails of unknown sex or age made up the remainder. Northern Idaho deer seasons have been an either-sex hunt for over 30 years preceding this study.

The adult-to-fawn ratio varies from 100:17.9 in 1952 to 100:33.3 in 1949 (Table 6). The three-year average was 100 adults to 19.9 fawns. The doe-fawn ratio varied from 100:58.3 in 1949 to 100:36.3 in 1952 and averaged 100:42.4. The 1949 figures were based on only 28 deer, whereas there were 93 in the 1950 sample and 132 in 1952. Fawns made up 15.2 percent of the take in 1952, 16.1 percent in 1950, and 25.0 percent in

1949. The extreme variability in the 1949 figures is probably due to the smaller number of deer sampled. Adult bucks outnumbered adult does 113:100, but only 69 fawn bucks were found per 100 female fawns. The over-all kill ratio averaged from the total population for three seasons was 98 males per 100 females out of 277 classified deer. Only check station figures are used here since it was discovered in going over the volunteer records at frozen food lockers that smaller deer (fawns and yearlings) are seldom placed in lockers or reported voluntarily.

In 1949 there was considerable doubt expressed that many deer had survived the spring die-off. Only seven fawns and three yearlings were among the 24 classified deer taken by hunters that fall. While the sample is admittedly small, the fawn crop may have been reduced due to the privation suffered by the does in the winter of 1948-49, and many of the 1948 fawns may not have survived to be taken as yearlings. Following the second consecutive severe winter and die-off, only 15 fawns were taken in 1950 of the 93 deer classified, or 16 percent of the known take. Twelve yearlings were checked (13 percent), and the remaining 66 adults comprised 71 percent of the total. Again it would seem that there was a very poor carry-over of the 1949 fawns and that the 1950 fawn crop was also much lower than is possible. The adult-yearling ratio for the 1950 harvest of 66:12 yields a ratio of 100:18 which indicates very poor survival of the 1949 fawns. In 1952, the age composition in the voluntary jaw collection (Table 7) indicated there were 11 adults harvested to 13 yearlings, or 100:118. This sample indicates a much better survival of young deer, perhaps due to milder over-wintering conditions for two years previous.

Check station figures (Table 6) showed that fawns made up only 15.2 percent of the 1952 kill. In 1952, 20 percent of the jaws collected

were from fawns, 44 percent from yearlings and 36 percent from adults (Table 7). This apparent increase in yearlings can possibly be attributed to the very mild 1951-52 winter with good survival. The fawn percentage is low, perhaps due to the small sample or to the hunter's reluctance to tag or to report a fawn. Since this is a perennial condition, nothing can be deduced from the actual figure other than trend. Hunters submit the heads of does and fawns more readily for jaw collections than heads of trophy bucks. This may be partially reflected in the larger percentage of fawn jaws in the collection than of fawns checked at the stations.

Table 7 is a summary of the age composition of 30 white-tailed deer jaws and 42 mule deer jaws donated by hunters in 1952. From this small sample of known-aged whitetails, the fawns and yearlings were 64 percent of the total collection. The $2\frac{1}{2}$ and $3\frac{1}{2}$-year-old deer that were born in 1949 and 1950, after the die-offs, were only represented by 3 percent of the take in 1952. Not one jaw of a $4\frac{1}{2}$-year-old whitetail or mule deer was collected. Deer over five years of age made up 26 percent of the group. This would substantiate observations made during the 1950 die-off regarding the unusually large number of older deer surviving the hunts to succumb to winter kill and of the poor fawn survivals in the winters of 1948-50. The combination of low hunter pressure and difficult hunting conditions for the few who do hunt tends to allow more deer to survive longer than could be expected under conditions more favorable for the hunter.

Winter count ratios

White-tailed deer are seldom seen until January or February in the study area, and then only during severe winters. Bucks have dropped

their antlers and the overlap in sizes of all deer makes positive identification in the heavy cover difficult or impossible. A California study (Interstate Deer Herd Comm., 1951) suggested that where any numbers of a group cannot be identified that the ratios for such a group should not be recorded because only the obviously identified deer are tallied, such as small fawns, or bucks with prominent antlers.

Of the 1447 whitetails tallied during the first quarter of 1950 (Table 3), only 93 were listed as adults, 46 as fawns and 1308 as unclassified for either sex or age groups. However, using the count of classified deer, we have a ratio of 100 adults to 49 fawns.

During the winter season of 1952-53, 119 white-tailed deer were observed of which 71 could not be classified as to sex or age. Of the 47 classified deer, three were bucks, 14 were does, and 30 were fawns (100 adults to 176 fawns). This indicates a better fawn survival during the winter but these data cannot be used to indicate ratios or to predict increase with any degree of accuracy.

Winter Loss ratios

In the winter of 1949-50, 459 white-tailed deer carcasses were found by project personnel or were reported by various cooperators. Of this group there were 145 adults and 90 fawns, or an adult-fawn ratio of 100:63; 38.3 percent of the total loss was comprised of fawns. An additional 224 deer were of unknown sex and age (Table 8).

The following winter of 1950-51 was mild and only 70 whitetails were known casualties. Two fawns, 22 adults and 46 of unknown sex and age were lost, mostly to illegal killing and accidents. This yields and adult-fawn ration of 100:9 (Table 9). During the winter of 1951-52

Table 8. Classified non-harvest[a] losses of white-tailed deer: 1950-51-53

	Adults			Fawns				
Year	Bucks	Does	Sex un-known	Males	Females	Sex un-known	Sex & Age un-known	TOTAL
1949-50	52	64	29	27	22	41	224	459
1950-51	8	14	-	1	1	-	46	70
1952-53	16	15	-	6	5	-	11	53
Sub-total	34	28	41	76	93	29	281	582
Total	198 adults			103 fawns				

[a] Period from the close of fall hunting season of one year to opening date of the next season

the Conservation Officer at Coeur d'Alene collected the jaws of 13 whitetail killed by cars, predators, and other accidents and they were all yearlings or older. There were only 19 fawns, 31 adults, and 11 unknown losses, mostly from accidents, tallied from the close of the 1952 hunting season in mid-December until the start of the 1953 season in mid-October. The adult-fawn loss ratio for this period was 100:35.

One hundred mature does were lost for every 82 bucks that succumbed and the harvest ratios indicate that there were 113 bucks per 100 does in the three-year cumulative hunter take (Table 9). Conversely, male fawns outnumbered female fawns by 122:100 in the loss ratios and the fall hunts reflected this differential morality (Table 6), by producing only 68 male fawns per 100 female fawns. A conservative assumption of a 50:50 sex ratio of fawns at birth would reflect a heavier loss of male fawns. This should be balanced later by increased mortality of female adults

which is somewhat corroborated by the over-all summary of sex ratios produced during the three-year investigation.

Ninety-one bucks (all ages) were post season casualties for every 100 does. Ninety-eight bucks (all ages) were killed by hunters for every 100 does. Of 875,973 deer taken in other states (Taylor, 1956) where both sexes are hunted, the ratio of males to females harvested was 133:100, indicating that generally hunters are more inclined to select males. Idaho hunters are inclined to select the first deer they encounter when hunting conditions are difficult.

Table 9. Indicated sex and age ratios in non-harvest losses of white-tailed deer: 1950-51-53

	1949-50	1950-51	1952-53	Three-year TOTAL
Adult : fawn ratio	100 : 62	100 : 9	100 : 35	100 : 52
Size of sample	145[a]: 90[a]	22 : 2	31 : 11	198[a]: 103[a]
Buck-doe ratio	81 : 100	55 : 100	106 : 100	82 : 100
Size of sample	52 : 64	8 : 14	16 : 15	76 : 93
Male-female ratio (Fawn)	123 : 100	100 : 100	120 : 100	122 : 100
Size of sample	27 : 22	1 : 1	6 : 5	34 : 28
Male-female ratio (Herd)	92 : 100	60 : 100	110 : 100	91 : 100
Size of sample	79 : 86	9 : 15	22 : 20	110 : 121

[a]This sample includes 70 animals which were not sexed.

Analysis of reproduction

Fifteen mature white-tailed does were examined during the spring loss checks in 1950 (Table 10). Thirteen does (including three very old animals) bore twin fetuses, one had a single fetus, and one very

old doe (10+ years) was barren. This yields a total of 27 fetuses for a doe-fetus ratio of 1:1.8. The doe carrying the single fetus bore a small left antler indicating possible hormonal disturbance of some years standing. This small sample seems none the less significant in view of the fact that this was the second consecutive severe winter these does were experiencing and that several of the casualties were by accidental means, not by privation. Thus the summer range was adequate for a normal nutritional recovery. Does that survived could have had at least as high a rate of twinning if no further losses occurred prior to parturition. The doe: fetus ratio of 1:1.8 indicates and excellent rate of reproduction.

Table 10. Numbers and sex ratio of fetuses for 15 white-tailed does[a]

No. of fetuses	No. of adult does examined
Twins	
Both Males	1
Both Females	2
Male and Female	3
Male and Unknown	2
Female and Unknown	1
Both Unknown	4
Single	
Male	1
Female	0
Unknown	0
No fetuses found	1
TOTALS	
No. of adult does examined	15
No. of male fetuses	8
No. of female fetuses	8
No. of fetuses, sex unknown	11
Does - fetus ratio	1 - 1:8

[a] Adult does - $2\frac{1}{2}$ years or older, all winter losses by various causes.

During the following winter the project biologists examined three does, all bearing twin fetuses, and four more examined by Conservation Officers were each bearing twins. In 1952-53 only two doe carcasses were checked and both of these carried twins.

A very high rate of twinning was reported by many local observers in the spring of 1953 which would corroborate the embryo checks above. No evidence of fawn breeding has been found and so few yearlings have been encountered in the losses that nothing can be said regarding their breeding activity. Evidence of larger multiple births was lacking in the embryo checks. Table 10 indicates that a fairly equal sex ratio exists at birth although the sample is admittedly small.

D4. E. L. Cheatum (1951a) examined three sets of ovaries and embryos and recorded the following data presented in Table 11.

The three analyses (Table 11) are by no means indicative of the potential productivity of all the whitetails inhabiting scattered protions of the million acre tract, but it is well to compare them with Cheatum's findings (1950) regarding malnutrition and reduced productivity.

The first doe, a young deer that was accidentally killed, was in good condition. She had produced two ova during the fall (1950) breeding season and was carrying two well developed fetuses. Also she showed evidence of having produced two ova the previous year and probably had dropped twin fawns the spring of 1950.

The second doe, a very old animal (10+ years) carrying twin fetuses, was killed near Prichard in mountainous Shoshone County. One fetus was destroyed, unfortunately, but the other measuring 173 mm. would indicate normal development. It was larger than either of the fetuses measured in doe No. 1 and was taken four days earlier. During

Table 11. Reproductive data from three white-tailed does[a]

Doe No.	Age of doe	Date killed	Length of fetus	Sex	Ovaries: Left	Ovaries: Right
#1	6	3/1/51	164 mm	F	2 current corpora lutea	No current corpora lutea
			171 mm	F	1 from previous year	1 from previous year
#2	10+	2/25/51	173 mm	F	2 current corpora lutea	2 current corpora lutea
			? (destroyed in utero)	?	1 from previous year	None from previous year
#3	9	4/15/51	211 mm	M	2 current corpora lutea	(decomposed)
			113 mm	F	1 from previous year	

[a]Road-kills from the study area, examined by Dr. E. L. Cheatum.

the fall of 1949 following a severe winter, doe No. 2 had only produced one ovum. Because of adverse factors (limited range at Prichard, or recent severe winter, and her advanced age) she may have produced one, or possibly no fawns in 1950.

The third doe checked was a 9-year-old animal accidentally killed near the Canyon Garage on Highway U.S. 10 in mid-April. The two fetuses showed a large difference in total length with the male measuring 211 mm. and the female only 113 mm. The right ovary was decomposed and no reading was obtained. The left ovary had produced two current corpora lutea and one the previous year. The area where she was killed had suitable food but lies in a heavy snowfall belt. Very few deer have wintered

there. Nothing can be determined about her 1950 fawning success due to the decomposed ovary but she had probably produced at least one fetus. During the fall of 1950 two and possibly more ova were produced and two were fertilized. The small female fetus may have been in the process of resorption rather than indicating retarded development.

Inasmuch as long continued reproductive activity will influence herd size, it is important to note that three of four very old does of 10+ years (Table 10) were carrying twin fetuses. Since these deer had survived one very difficult winter and nearly made it through the second, it would appear that the high rate of productivity noted elsewhere for white-tailed deer is also possible here, with the possible exception of fawn breeding.

The earliest fawning date recorded in this study was May 10, 1953, at the Farragut Wildlife Refuge. The peak of fawning as judged by field observations probably occurs about June in this area.

Discussion

Productivity studies are dependent upon the existence of accurate information regarding total population of a herd or similar game unit, the sex and age ratios of the animals comprising that unit, the reproductive rate of the species in that particular environment, and the ratio and extent of sex and age mortality.

As stated previously, securing an adequate sample has been an important factor limiting our ability to determine the productivity of this herd. Clues exist as to the nature of the conditions but not enough samples exist of sex and age ratios, ovarian analyses or counts of fetuses. Enough work has been done on white-tailed deer in Michigan, New York and elsewhere, however, to show that under favorable conditions,

whitetails will produce close to capacity, or two fawns per doe, after they reach $2\frac{1}{2}$ years of age. It has also been shown that undernourished does may not breed or will produce only one fawn instead of the customary twins (Cheatum and Severinghaus, 1950; Severinghaus and Cheatum, 1956).

It must be concluded that winter sex and age ratio counts are generally unsatisfactory in that sex and age counts cannot be made over the whole study area before antlers are shed, and the late appearance of game animals on winter ranges during even the severest winter precluded accurate identification of sexes. Unless a heavy early snow concentrates whitetails, and a crew of skilled observers is available to make the classified counts, it would seem advisable not to attempt this method on the Coeur d'Alene.

Herd composition counts before and after the hunting season are not practicable on this study area, as discussed previously under Numbers. Herd composition for this population can best be based on cumulative harvest data. Winter loss composition figures alone are not suitable since the data do not reflect a cross-section of the herd.

The male-female ratio of 98:100 from harvest records (277 classified deer) for three seasons would indicate that continuous either sex hunting is not causing an imbalance in the herds. The high rate of twinning indicated in the few fetus counts also reflects a possible high reproduction potential under favorable conditions. Our evidence indicates that a nearly equal number of bucks and does are produced at the time of parturition. Differential mortality seems to be operating on the sexes from then on with more female fawns than buck fawn being taken by hunters and slightly more adult bucks than does. Old does and male fawns seem to

be especially vulnerable to winter losses. Fawns constituted 34 percent (100:52) of all whitetails lost to causes other than hunting over the three-year period covered by this study.

Accurate productivity data on white-tailed deer must be obtained from a study designed to that end. As management techniques become more refined, and the need for more detailed information is justified by a more intensive management program, then details of productivity for each species can be investigated. At present there does not appear to be any unusual decimating factor adversely effecting production of local white-tailed deer. The low proportion of fawns (20 percent) in the kill might be caused by loss of fawns from birth to the first hunting season; heavy illegal kill; unreported legal kill; or a hunter preference for larger deer. Present data are insufficient for the determination of the relative importance of these four possible factors.

A figure representing the total white-tailed deer population may be unobtainable with past procedures but a close estimate of the number, based on the best total counts during severe winters, is an attainable goal. By adding the probable increase and removing the estimated losses each year, a fair check on game numbers could be attained. As more reliable censuses are made during the occasional severe winters, when deer are concentrated, the base figure would have to be revised to establish a new starting point for further estimates.

Mortality

Harvest

Forest Service estimates (Table 1) were the only available source of information on deer harvests for the Coeur d'Alene National Forest prior to the initiation of this study in 1949. Checking stations were operated

Fig. 12 An old white-tailed buck is one of the most difficult of North American game animals to hunt. Due to their wariness and the rough, densely timbered areas they inhabit, it is difficult to achieve an adequate legal harvest.

by forestry personnel (1935-37) and estimates of the combined kill of whitetails and mule deer, and of hunter pressure have been made annually by the rangers since 1921 (U.S.F.S., 1921-58). Since 1954 the Idaho Fish and Game Department has relied on hunter-card questionnaire surveys to arrive at harvest figures for each game management unit (Table 12).

Interviews with old hunters regarding the trend in numbers and kills revealed that few of them considered the hunting as good in the early 1950's as it was formerly. During the study period, more deer are estimated but an increase in hunters and additional roads make far greater gun pressure possible. The annual kill estimates have fluctuated, depending on weather conditions and previous winter losses, but generally have shown a gradual rise, with an increase in game. The quality of the hunters and the decline in quality of deer hunting as a sport are discussed below.

History of deer harvest (1921-1953). In 1921 there were only an estimated 490 whitetails and 165 mule deer on the Forest (Figure 8). By 1925 both species totalled 950 animals despite local decreases where excessive hunting was said to be reducing them, as near the city of Coeur d'Alene. In 1926 thousands of acres of the Coeur d'Alene Forest were ravaged by forest fires. Whitetail game range was destroyed temporarily. Game increases for the next six yerrs were estimated to have been minor. Hunter-take during the 1920's ranged from 40-125 (average 70) deer each fall for an average hunter success estimated at 24 percent. This would amount to less than ten percent of the estimated herds.

By 1931 following several easy winters, a herd of 850 whitetails, 290 mule deer and 80 elk were estimated on the Forest. The original

plant of elk at Grizzly Creek was slow to increase due to poaching and adjustment to the area. This was another fire year with 30,000 acres destroyed near Magee. In the fall of 1931, 585 hunters took 191 deer (33 percent success). Old timers considered the hunting then the best they had ever had; deer were abundant and "gunners" were not. With an estimated combined deer population of about 1100, that harvest figure would have accounted for nearly 20 percent of the herd.

The winter of 1931-32 proved to be unusually severe and over 700 white-tailed deer were known to have succumbed in the interior Shoshone County region along the Coeur d'Alene River and its tributaries. The next fall the estimated kill dropped to 133 deer and population estimates were revised down to 875 animals. A slight increment in 1933 was nullified that winter by more heavy snows and reported losses of deer.

A series of easy winters from 1935 to 1945 aided the deer, and increases were estimated at 200 whitetails and 100 mule deer annually until an estimated high of 2,390 whitetails andl,210 mule deer was reached in 1945. During those years the estimated harvest increased very noticeably to a peak of 540 deer in 1945. The 1945-46 winter was severe and many losses to winter kill were recorded. A heavy harvest in 1946 of 800 more deer (29 percent hunter success and 25 percent of the two herds) reduced the estimates for the Forest to 2,250 whitetail and 940 mule deer. The legal hunting pressure was lessened during the war years but, nevertheless, war time meat shortages and lack of enforcement men were believed to have resulted in heavy illegal killing. The population estimates kept rising however, until the post war years, when the heavy winter die-offs (previously mentioned) occurred.

In 1950 the whitetails were below the 1946 estimate by 150 deer, but

the mule deer estimate had nearly doubled (940 to 1,800) in five years. The heavy loss of whitetails during both springs of 1949 and 1950 and following heavy hunter kills in 1946-47-48, served to stabilize their numbers. By 1953 the estimates had reached an all-time high of 2,400 white-tailed deer and 2,300 mule deer. The elk estimate increased to 1,300, despite a removal of 1,100 animals during four consecutive seasons.

Concern has been expressed over the slow increase of the mule deer despite the extensive habitat created for them by the 1926 and 1931 fires. During the 1949-50 seasons this deer provided twice the known kill as have the whitetails. Vulnerability to hunting is undoubtedly a factor.

After a reported heavy harvest of both species of deer in the fall of 1948 and a severe die-off of whitetails in the spring of 1949, sportsmen expressed much concern over the advisability of an open season in 1949. An early season (October 15-November 15) in the exterior (Kootenai County and Bonner County), was offered as a compromise. No change was made in the interior (Shoshone County) where that is the usual season.

The full-time check stations (Enaville and Dobson Pass) and constant roving checks supplemented with volunteer reports yielded data on only 28 classified and 28 unclassified white-tailed deer killed in 1949 (Table 5). The combination of low deer numbers, lack of interest in hunting for deer, and the new interest in the elk hunting all combined to produce this low harvest. Obviously many deer were being taken that were not reported.

In 1950 four stations (Enaville, Dobson, Bunko and Hayden) were manned to provide more data on the deer take. After the second consecutive heavy die-off in the spring of 1950, the recorded take of whitetails

was double that of the previous year. This may be a result of doubling the number of game checking stations. An analysis of the volunteer report showed that hunters were reluctant to record deer taken in areas not covered by checking stations. The percentage of fawns checked at stations was three time as great as that found in volunteer reports.

The deer take was checked only at Enaville for the first eleven days of the season in 1951. Fifteen white-tailed deer were checked out during that period.

In 1952 a combination of part-time stations, roving checks, and volunteer reports raised the tally to 273 deer taken during the regular and extended season and a total kill of 350 whitetails was the estimated removal for the season.

The number of hunters, meanwhile, has risen from an estimated 250 in 1925 to 6,700 by 1948 and 8,482 by 1958 (Rogers, 1959). Hunter success for the 1940's, prior to the recent die-offs, ran about 12 percent except for the heavy kill in 1946. After the heavy winter losses, the hunter success on deer dropped to an estimated 6 percent in 1949 and 1950 and 5 percent in 1952. (Table 13).

Several factors besides the die-offs influenced those figures. Check station records recording actual hunter numbers and total game take were used for the 1949-52 seasons, but Forest Service estimates were used previously. The 1948 estimate of 6,700 hunters may be too high since the total number checked in through four stations and by roving patrols in 1950 was only about 3,500 (Table 13). Since the estimates for game kill are subject to the same human error they can be expected to be fairly consistent over the years. Forest Service estimates are probably close to the actual hunter success.

Table 12. Estimates of deer and elk harvests for the Coeur d'Alene area: 1954-59

Year	Estimated deer harvest			Estimated elk harvest		
	Forest Service estimate	Game Biologist estimate	Game department card survey[a]	Forest Service estimate	Game Biologist estimate	Game department card survey[a]
1954	500	Checked 59 Estimated 400	2222	50	No check Estimated 459	617
1955	420	Checked 276 Estimated 470	2604	280	No check Estimated 345	797
1956	530	Checked 17 No estimate	1849	300	Checked 21 No estimate	662
1957	650	Checked 13 No estimate	1832	335	Checked 50 No estimate	666
1958	790	Checked 18 No estimate	2388	300	Checked 58 No estimate	978
1959	--	Reported poor harvest with need for extended season	--	--	--	--

[a]Card survey figures are based on slightly different boundaries than that of the study area boundaries.

TABLE 13. SUMMARY OF HUNTING PRESSURE AND HUNTER SUCCESS FOR DEER AND ELK: 1949-52

YEAR	NUMBER OF HUNTERS CHECKED	MEAN NUMBER OF TRIPS THROUGH STATION	TOTAL TRIPS THROUGH STATION	MEAN NUMBER OF DAYS HUNTED	TOTAL DAYS OF HUNTER PRESSURE	NUMBER OF SUCCESSFUL HUNTERS[A]	MEAN DAYS PER SUCCESSFUL HUNTER	NUMBER OF UNSUCCESSFUL HUNTERS	MEAN DAYS PER UNSUCCESSFUL HUNTER	PERCENT HUNTER SUCCESS[B] DEER TAKEN / DEER HUNTERS	PERCENT HUNTER SUCCESS[B] ELK TAKEN / ELK HUNTERS
1949	2653 AT TWO STATIONS	2.1	5571	2.5	6633	397	3.4	2256	2.3	6%	11%
1950	3500 AT FOUR STATIONS	2.6	9100	2.9	10150	438	3.6	3062	2.8	6%	6%
1951	1500 AT ONE STATION	STATION OPERATED ONLY DURING 11-DAY ELK HUNT				150		1350		3%	8%
1952	2345 AT TWO STATIONS	1.8	4221	2.3	5394	264	3.2	2081	2.2	5%	9%

[A] A SUCCESSFUL HUNTER WAS ONE WHO BAGGED A DEER OR AN ELK, OR BOTH.
[B] STATION RECORDS REVEALED HUNTER'S OWN STATEMENT OF WHETHER HE WAS HUNTING DEER OR ELK.

Forest Service estimates on total hunter kill reveal that a combined total of 2,317 mule deer and whitetails were taken during 1928-40, and an estimated 3,473 whitetails and 1,975 mule deer (5,448 deer) were taken from 1940-53. The increase in hunter numbers was accompanied by an increase in deer as well as in more than doubling the total harvest of deer.

Recent harvest estimates (1954-59). Three different sources of information are available to bring the harvest data up to date for the period from 1954 to the present -- the Forest Service estimates, records obtained by the District #1 Game Billogist, and statewide hunter questionnaire card returns for the Coeur d'Alene Management Unit. These records are summarized in Table 12 by years and by species where known.

The 1958 Forest Service estimates (U.S.F.S., Coeur d'Alene files) gives 2,320 whitetails, 2,000 mule deer, and 1,875 elk, which indicates a decline in mule deer and a substantial gain in elk numbers.

Table 12 indicates a steady increase in deer harvest since 1955, according to Forest Service estimates but this trend does not hold true in the card survey records which indicate decreases in 1956 and 1957. If the early Forest Service estimates are thought to be too conservative, then it might also be questioned that the results of the card survey are too high. One possible answer lies in the change in areas covered by the card survey. The boundaries have been adjusted twice for the card survey which renders direct comparisons impossible.

Factors influencing harvest. As early as 1925, forest rangers stated that the Coeur d'Alene is in effect, a natural preserve since the lack of roads and early fall snows close up most of the area and reduce hunting to the periphery. They pointed out that it was hard to hunt because of the thick brush, steep canyons and a limited amount of game.

After 35 years, some of those conditions are no less true. Snows deep enough to force the mule deer to lower elevations where they are accessible have already blocked the roads and made the deer areas inaccessible to hunters. It takes less snow to move whitetails and the numerous roads along foothill ranges make the deer vulnerable to hunters when snows get deep. The extra pressure of all the hunters blocked out of the mule deer country, but added onto the normal pressure of road hunters, has frequestly combined to noticeably increase the kill of whitetails in a few areas. This factor has undoubtedly affected sportsmen's clubs in their protests against late seasons.

Without the aid of early fall storms the legal kill of both species of deer is seldom believed to go over 10 percent of the herd. The low take in recent years, which necessitated an extended season in 1952, has been partly attributed to the scarcity of game following the winter die-offs and partly to unfavorable weather. Actually the only weather favorable to an increase in kill would be a sudden, heavy fall snowstorm followed by clear, cold weather. Warm, sunny fall days are deemed to be too dry and noisy for good hunting. Wet, cold weather discourages hunters who vow that the deer "hole up" in the brush and can not be driven out. Crusted snow is too noisy and with more factors hindering the hunters than the deer, hunter success is generally quite low.

Records and interviews revealed that the successful hunters worked harder than unsuccessful hunters, averaging nearly twice as many days in the field. Since many successful hunters connected on the opening day, it would appear that the remaining successful hunters averaged more than the indicated time in the field (Table 13). During every season the kills were directly related to intensity of hunting pressure. This was especially noticeable on opening and closing dates, holidays and weekends.

In addition to the difficulties of hunting widely scattered and wary game animals in timbered, mountainous areas, the low take is also related to the quality of the hunter. There still remain a small number of skilled hunters, probably 10 percent, who are physically and mentally capable of getting game under even the most difficult conditions. Beginners and other less skillful hunters add to the take each year by luck or persistent road hunting, but it is this latter group that dilutes the hunter success figures and lends credence to the rumor that the game is getting scarcer. The vast network of roads aids in hunter distribution but in actuality it has created an unfavorable condition of road hunting and spelled the end to camping out. Hunters who have maintained a high degree of success over the years have almost invariably hunted one area as long as it was producing game.

The cripple-kill loss on white-tailed deer was not determined over the whole area but may be considerable. During the 1952 fall hunt a small area near Harrison (Skyline Ridge) was covered by local hunters familiar with the hunting conditions. Twelve white-tailed deer carcasses were found on this ridge and 40 deer were known to be taken out by hunters. This cripple-kill loss of 23 percent of the bag may be less where less experienced men hunt. Taber (1951) reported a cripple-kill loss of bucks equalling 42 percent of the take-home kill of bucks in California on legal buck-only hunts. Costley (1948) reported crippling losses of all age and sex classes equalling 42 percent of the back harvest where bucks only were hunted and 25 percent in either-sex hunts in Utah.

We can not make the deer less wary, but we can manipulate the seasons to effect the desirable removals. Long seasons to give hunters an early chance at the mule deer and a later chance at whitetails may be the answer.

Two-deer seasons with local variations (one tag for each species) have not been fully explored. Ideally it would spread out the hunting effort, thereby lessening the danger to hunters themselves from large numbers attempting to kill game during a short season. There is a tendency, however, for the majority of the hunters to wait until the end of the season, no matter how long it may be. Few will go on record as favoring a December season but not many arguments were raised against an extension in December of 1952 to achieve a greater kill. Also the strong charges in some quarters following the 1949 and 1950 die-offs that there were no deer left, were not followed by suggestions to close the season. Since kill is related to pressure, the desirable kill will never be achieved unless a more honest attempt at actual hunting is realized by a considerably greater number of hunters than occurs today. Certainly when winter losses are known to be nine times as heavy as the fall hunter-take it would seem desirable to work for more effective harvests. The effects of illegal hunting on the herds are discussed below in the section on post-season losses.

Harvest summary. It seems significant that with an increase in check stations, there was an increase in the total recorded deer kill. As the roving patrols and requests for volunteer reports were intensified there was a further increase in reported take. However, the actual yearly kill may not have changed appreciably.

The change is not as noticeable in the station records as it is in the roving check and volunteer kill reports. In 1949, 32 deer were tallied outside of the stations. Forty-five were recorded in 1950 and the extra stations produced over twice the kill tallied the previous year. By 1952 the station kill record was only 46 deer but the kill reported from other sources had increased to 97, perhaps a reflection of more

intensive weekend checking (Table 5).

Of the 300 whitetails tallied during the three hunts, nearly half (143) were taken during the fall of 1952. While this may be caused by more intensive checking and the extended season, it probably also reflects herd recovery following the 1949 and 1950 die-offs.

The male-female ratio for the three hunting seasons (Table 6) was very close to 1:1 with 137 males and 140 females (49.8:50.2). Fawns comprised 14 percent of the total recorded kill for the three-year study. Fewer fawns were reported at stations than were checked at lockers, a condition which has also been noted at checking stations in western Montana (Taber, 1959).

Widely varying weather conditions during the fall hunting season, periodic changes in length of seasons, and variables such as unemployment due to strikes or cessation of logging which contributes more hunters, have all affected the game harvests.

The most successful hunters, here as elsewhere, work harder for their game, averaging nearly twice as many man-days of hunting as the unsuccessful hunter. Hunter success is generally low, averaging less than 10 percent in ordinary seasons.

Manipulation of seasons and bag limits is a distinct possibility for better herd management. The statutory power exists; all that is needed now is public understanding and support.

Non-harvest losses

After the severe 1948-49 winter when an estimated 15-20 percnet (U.S.F.S. files) of the white-tailed deer in the main and Little North Forks of the Coeur d'Alene succumbed, it seemed advisable to collect as much information as possible regarding the individual herds for correla-

Table 14. Harvest and non-harvest losses of white-tailed deer: 1949-51, 1952-53

Causes	1949-50	1950-51	1952-53	Total	Percent
Illegal killing	95	40	19	154	17.5
Malnutrition	82	1	0	83	9.4
Predation	50	2	0	52	5.9
Disease	2	0	1	3	0.3
Old age	34	3	1	38	4.3
Accidents	41	7	32	80	9.1
Unknown	155	17	0	172	19.5
Total non-harvest	459	70	53	582	66.0
Total harvest	56	101	143	300	34.0
Total mortality	515	171	196	882	100.0

tion with range conditions, hunter harvest, and all other losses. A very light known takeof 56 whitetails during the fall of 1949 would seem to support the local opinion that the previous winter had severely reduced the deer. The extreme opinion that there were no deer left was disproved when 1,447 whitetails (900 in Shoshone County) were tallied during the 1949-50 winter census over the study area as a whole (Table 4).

As the record winter snows piled up for the second consecutive year, deer losses began to mount. Four hundred fifty-nine whitetails were recorded as losses to all causes other than legal hunting from August 1, 1949, to June 1, 1950 over the whole Forest, with nearly 400 recorded in the interior, in Shoshone County (Table 14).

Table 15. Summary of composition of non-harvest losses of white-tailed deer during 1950 die-off

Causes	Adults				Fawns				Sex and age unknown	Total	Percent of total loss	Percent of classified loss
	Bucks	Does	Unknown	Sub-total	Males	Females	Unknown	Sub-total				
Illegal kill	2	8	1	11	0	2	4	6	78	95	20.7	31.2
Malnutrition	12	6	15	33	21	13	12	46	3	82	17.7	27.0
Predation	6	4	0	10	3	2	3	8	32	50	10.9	16.4
Disease	2	0	0	2	0	0	0	0	0	2	0.4	0.7
Old age	15	16	3	34	0	0	0	0	0	34	7.4	11.2
Accidents	8	16	0	24	2	2	1	5	12	41	8.9	13.5
Unknown	7	14	27	48	1	3	26	30	77	155	33.8	-
Total	52	64	46	162	27	22	46	95	202	459	100.0%	100.0%

Table 16. Monthly summary of non-harvest losses of white-tailed deer by sex and age composition and causes: 1949-50

		1949		1950							
		Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Total
Adults	Bucks	2	1	2	5	10	19	13	0	0	52
	Does	0	3	3	6	6	24	19	3	0	64
	Unknown	0	0	0	2	2	18	7	0	0	29
	Subtotal	2	4	5	13	18	61	39	3	0	145
Fawns	Males	0	0	1	1	7	14	4	0	0	27
	Females	0	1	0	0	3	9	9	0	0	22
	Unknown	2	0	1	1	7	17	13	0	0	41
	Subtotal	2	1	2	2	17	40	26	0	0	90
Unknown sex and age		0	10	8	87	20	57	30	0	12	224
	TOTAL	4	15	15	102	55	158	95	3	12	459
Illegal kill		3	11	1	58	3	14	3	2	0	95
Malnutrition		0	0	0	2	15	50	16	0	0	83
Predation		0	1	3	30	6	4	6	0	0	50
Disease		1	0	0	0	1	0	0	0	0	2
Old age		0	0	0	2	0	14	20	0	0	36
Accidents		0	1	10	4	6	14	5	1	0	41
Unknown		0	2	1	6	24	62	45	0	12	152
	TOTAL	4	15	15	102	55	158	95	3	12	459

During the six months of winter and spring field checks the project biologists snowshoed and hiked 550 miles and covered additional areas by boat, life raft, truck and plane. Organized checks of losses were carried on only in areas where attempts at total live counts had been made. An intensive search for carcasses was made on five of the major wintering areas (Sub-units Nos. 6, 7, 8, 9, 11) in the interior, in Shoshone County (Figure 8).

Supplemental feeding was carried on steadily for three to three and one-half months in two sub-units 6 and 11, partially for six weeks in sub-units 7 and 8, and no feeding was attempted on the isolated up-river ranges in sub-unit 9 (Table 17 and Figure 13).

The over-all known loss in the winter of 1949-50 amounted to nearly one-half of the known white-tailed deer populations in Shoshone County. No systematic attempt was made at determining losses in the exterior, in Kootenai County, but the known losses indicated a much less severe reduction with starvation a minor factor. A detailed discussion of losses by causes follows (see Tables 14, 15 and 16).

Losses to starvation. At the onset of this study there were few literature records pertaining to winter losses of white-tailed deer unless due to starvation on over-browsed ranges. Severinghaus (1947) stated that deer mortality in the Adirondacks of New York varied from year to year with the severity of the weather, and that deep snow was the principal weather factor involved. Edwards (1956) in a survey of records of ungulate abundance in British Columbia, concluded that snow depths may be the primary cause of a number of factors observed in winter mortality of ungulates. It soon became obvious on this study area that severe losses of deer were occurring on ranges where forage utilization was light.

Robinette (1956) recently acknowledged this possibility:

> Most of the drastic reductions recorded for deer herds exclusive of those through hunting have been associated with over-stocked or inadequate ranges. It seems probable, however, that severe losses could occur on undepleted ed winter ranges in some of the northern regions under unusually critical wintering conditions of deep snow and sub-freezing temperatures.

Severinghaus and Cheatum (in Taylor, 1956) also commented on this situation of the inevitability of some loss in extreme winters. Cowan (in Taylor, 1956) has described similar severe winter losses of coast black-tailed deer in British Columbia and southeastern Alaska.

Past history of winter losses. In the spring of 1932, 722 white-tailed deer carcasses were found along the North Fork following a very severe winter. The 1931 McPherson fire near Magee which devastated over 30,000 acres destroyed most of the white-tailed deer winter ranges along the river. The following winter deer from these areas were forced to emigrate further down-river where they increased the feeding pressure on already limited resources. Two hundred deer were found dead near Bumblebee Campground, 167 along the lower main river, and 355 carcasses were found along the upper North Fork between Prichard and Camp Nowhere. The bulk of the up-river losses occurred on Shoshone Creek (also known as Big Creek). Entomologists doing insect-control work on tributaries of the upper North Fork in the spring of 1932 reported finding numerous carcasses on Dry, Venus, Sissons, Teddy, Little Canyon and Emery Creeks in areas not covered by the Forest Service loss estimates (Table 1). It seems entirely possible that the losses equalled or exceeded 1,000 animals (U.S.F.S. files, 1921-58).

The Forest Supervisor writing on this loss admitted that the causes of death had not been determined but thought perhaps long continued foraging on a single variety of feed, and food shortages might have set the

stage for an epidemic. Cheatum examined these roports and expressed an opinion that contagious disease was not the cause of death but rather the losses were due to excessive game numbers, poor quality and low availability of feed, combined with severe winter conditions. The lung hemorrhages noted are similar to those referred to in Gerstell's studies (Cheatum, 1951b). The habit of whitetails previously described, of preferring cover to forage, undoubtedly contributed to their plight.

The Forest Service records seldom indicated the amount of feeding attempted locally but during the winter of 1931-32 aerial placement of hay was attempted below Flat Creek on the upper North Fork to alleviate the food shortages resulting from the 1931 fire at Magee and the subsequent heavy snows. Many individuals also put out hay on their own and there is no record of the locations, amounts or success. Spring deer loss surveys showed very little use of the hay placed along the river above Prichard and it was noted that many dead animals were found nearby.

In 1943 another local die-off was reported with 50 carcasses being found on the Little North Fork near Bumblebee Campground. No mention was made of any feeding attempts. In 1945 rangers reported finding many deer carcasses on the Wallace District in Shoshone County.

The early heavy snows in November 1948 continued to Febru ry 1949 and forced game down to the lower elevations all over Shoshone County and parts of Kootenai County. Many very old animals that had escaped hunters and managed to eke out a few extra years of life during successive mild winters, finally succumbed. Nevertheless, one-half of the estimated 15-20 percent loss was fawns (U.S.F.S. files). The remainder was made up of older animals, especially bucks. The Idaho Game Department officials for the area estimated the loss at 725 deer and 104 elk, presumably for the

five northern counties. This estimate is now believed to be very much less than the actual loss. The total loss for the Coeur d'Alene Forest alone, most of which occurred in the mountainous interior, was probably 1,000 white-tailed deer, plus an undetermined number of elk and mule deer. There is no way of knowing the extent to which starvation losses reduced the herds or predisposed losses to other factors. Public demand for hay feeding was partly met by the placement of 37 tons of hay in Shoshone County (north of the St. Joe Divide) in January and February of 1949 by the Idaho Fish and Game Department.

Current history of winter losses. No one predicted another severe winter on 1949-50 but it occurred (Figures 3, 4 and 5). Conditions for game were actually more severe than in 1948-49 due to the longer winter, colder weather and late spring storms (Figures 10 and 11). Over 300 elk had been removed by hunters the previous fall but the deer harvest was low which left a herd of unknown size to over-winter. It can be seen that the cumulative effect of two successive severe winters would adversely affect the survival results the second yerr. Also the heavy loss of fawns and old animals the year before the study was initiated would also affect the age composition of losses during the following year.

Some feeding was begun January 1, 1950 by ranchers and by the end of the month public pressure had again produced supplemental feed from the Game Department. No feeding program was carried on directly by the Department but supplies were given to the ranchers or sportsmen who fed the deer along the main river and Little North Fork. As a result of two consecutive die-offs and public demand for a feeding program, Department funds were allotted for the construction of two hay sheds near Bumblebee Creek and Prichard. These sheds, which are stocked with hay and cubes, have not

been utilized since they were built in 1950.

The total estimated loss of 1,000 deer in 1950 was composed of losses attributed to many causes. Definite loss by starvation was determined for 82 deer which number was 17-7 percent of the total recorded non-harvested loss (Table 14). If only animals lost to known causes are considered, the starvation loss was 27.0 percent of the known loss. On the basis to total mortality, including known harvest for the 3-year period, starvation losses amounted to 9.4 percent. Admittedly many of the casualities attributed to accidents, poaching and predation were predisposed by weakness and lack of alertness, but it is also not known how many losses were induced by unwise supplemental feeding. Destruction of carcasses by scavengers or by deterioration before the field personnel could get around to each area, resulted in large numbers of animals being tallied as lost to unknown causes.

When dental wear indicated extreme age (over 10 years) the cause of death was arbitrarily attributed to old age rather than to malnutrition, which may have accompanied it in a secondary role. In computing the percent of herd loss in these areas, the total number of recorded losses was compared with the largest total of live animals seen in the area during the mid-winter surveys. The ratio of dead to live animals is felt to be as accurate as it was possible to obtain.

Each sub-unit of game range has different conditions of snow, cover and forage, herd numbers, past history, and current differences in land-use. Game from 200,000 or more acres of mountainous forested land in Shoshone County is forced onto limited areas by heavy snowfalls. Less than 10,000 acres of marginal winter ranges are available to white-tailed deer there, principally along the little North Fork, lower and upper Main

Table 17. Classified losses of white-tailed deer on four winter range sub-units, Shoshone County; 1949-50

Causes of loss	#6 - Little North Fork No.	#6 Percent of known causes	#11 - Prichard Lost Creek No.	#11 Percent of known causes	#8 - Prichard Junction No.	#8 Percent of known causes	#9 - Lost Creek Camp Nowhere No.	#9 Percent of known causes	Total discovered loss by causes
Malnutrition									
(a) Fawns	32	41	8	17	6	7	5	10	51
(b) Adults	18	23	9	20	4	4	8	16	39
Old age	18	23	6	13	4	4	11	22	39
Accidents	7	9	7	15	16	18	4	8	34
Illegal loss	1	1	10	22	56	64	2	4	69
Predation	2	3	6	13	3	3	19	39	30
Sub-total of all classified losses	78	-	46	-	89	-	49	-	262
Sub-total of all unclassified losses	42	-	37	-	9	-	21	-	109
Total discovered loss by sub-unit	120	-	83	-	98	-	79	-	371
Total herd No.	163	-	100	-	250	-	187	-	710
Percent of herd lost and feeding period	73.6%		83.0%		39.2%		37.4%		52.8%

77.2% average loss, long feeding period, Jan.1 - April 15, 1950

loss, short feeding periods occasional week-ends Jan. 1 - Feb. 15, 1950

loss, no feeding

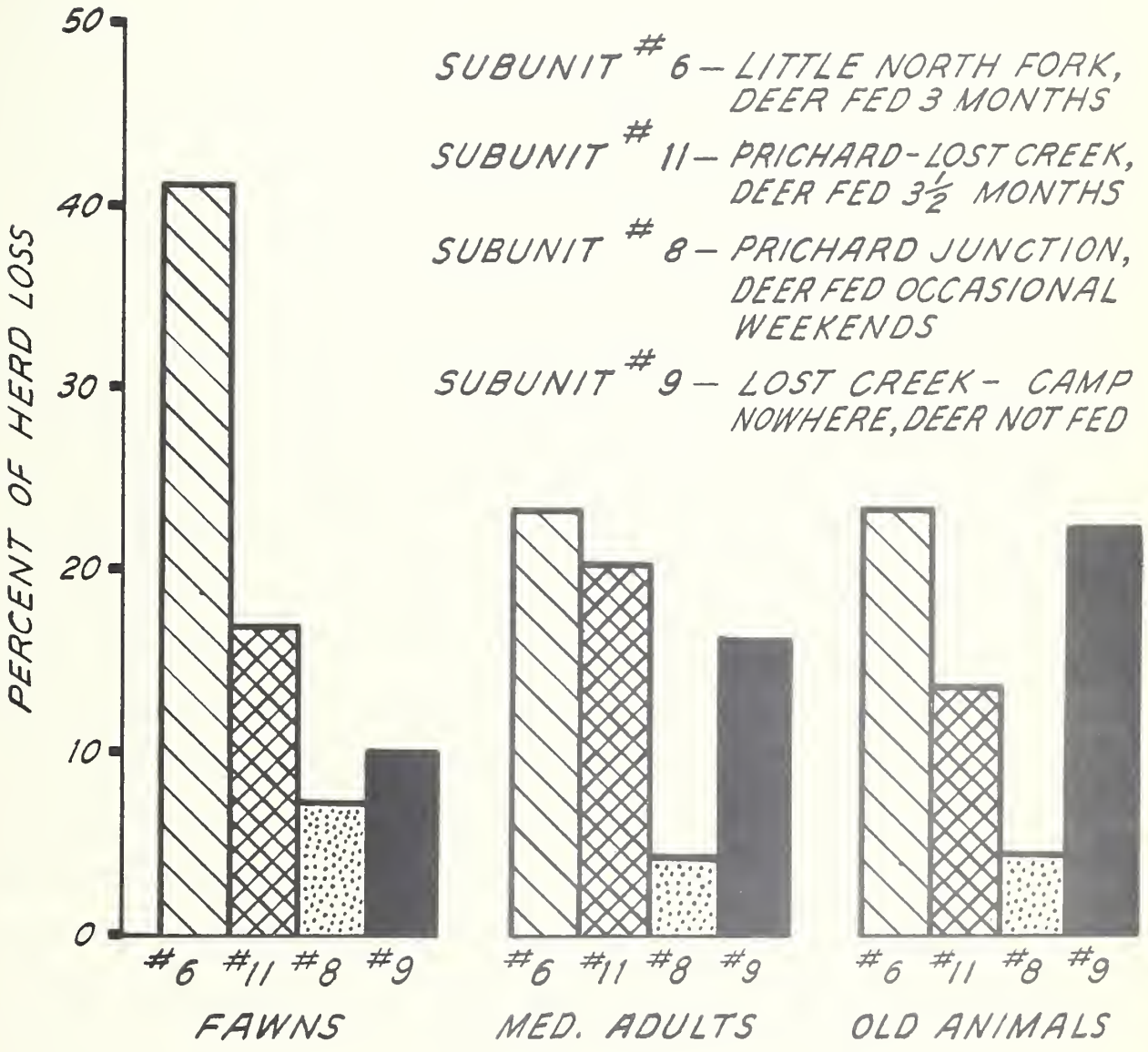

Fig. 13. Percent of herd loss by starvation by age groups on four areas, with reference to winter feeding: 1949-50 Source: Table 17

River, Prichard Junction, and Prichard to Lost Creek. The details of the losses by sub-units were previously reported (Pengelly, 1954).

Discussion. Five hundred and eighty-two white-tailed deer were known losses to causes other than hunting during the first three years the study was in progress (Table 14). During thes same period, hunters took only a recorded 300 white-tailed deer from these same herds (Table 5). Of the non-hunting mortality 459 deer, or 79 percent, were lost the first winter of 1949-50. Forest Service estimates of 20 percent losses for the 1948-49 winter would have removed a minimum of 440 deer from herds estimated to total over 2,200. This reduction is much less than the normal increment. The known loss of 459 deer in 1950 is less than half of the total estimated loss of 1,000 deer for the whole area. Thus it can be seen that possibly 1,600 or more deer were removed by causes other than legal hunting from 1949-53 --1,440 of which were lost in two consecutive winters. Many observers feel that the losses were greater in 1949 than in 1950 so it is conceivable that the Forest Service estimate of 20 percent loss is too conservative, as might be their total census estimate. Experience here and elsewhere leads us to believe that the total loss probably approached 1,000 deer for each of those winters. As to the quality of the loss, the known adult-fawn loss ratio for the three years is 100:52; but for the 1950 die-off alone it was 100:67. It is unfortunate that accurate adult-fawn and doe-fawn counts could not have been made for each of the major sub-units for later comparison with known losses.

An intensive feeding program above Prichard, involving as much as four man hours per day for 100 consecutive days in which four tons of alfalfa hay and one ton of protein cubes were distributed for 100 white-tailed deer, is associated with a loss of 83 animals contributed by all causes

during the winter and spring of 1949-50. At the same time a feeding program lasting for 90 days for a minimum of 163 deer, resulted in a known loss of 120 deer, or 74 percent of the Little North Fork herd. Near Prichard Junction, where hay feeding was discontinued after poachers shot some deer at the feed lots, 98 deer were lost from a herd of 250 (39 percent). This figure includes a 22 percent poaching loss. Above Lost Creek in the severest wintering conditions deer are faced with in the study area, 70 deer were lost from a known herd of 187 animals (37 percent).

It would appear that under the severest conditions faced by wild herds in the intermountain area that from one-third to one-half of the animals may be lost to a winter kill involving many causes. Possible the initiation of feeding programs in several areas increased natural losses by exposing some animals to many new hazards associated with the feeding program. While it appears from winter loss records that the white-tailed deer suffered the heaviest losses, there are several factors contributing to this condition. Whitetails are more susceptible to winter-loss than elk and mule deer, but they are also the most abundant species on the study area. The winter casualties of whitetails are also easier to find. The significance of this loss from a management standpoint is evaluated in one sense when recognize that many more animals were wasted than were legally harvested.

Summary. It is an established fact that white-tailed deer have perished in large numbers on ranges along the North Fork and the Little North Fork during severe winters in the past. Prior to this study there has been little correlation between game numbers, range conditions, snow conditions, artificial feeding and total losses. It appears that the attempts to feed herds during the past severe winters have not been success-

ful for a variety of reasons.

Trouble areas can be due to climatic conditions, to range conditions, to herd numbers, to the attitude of local personnel, to public attitude or any combination of all of these. Locally we have at best, marginal ranges that quickly become death traps for deer when deep snows bury the available feed.

Edwards (1956) stated that the abundance of food and cover, operating singly or together, could be major factors for either increasing or decreasing the effects of deep snow. Perhaps habitat manipulation to alleviate the periodic winter losses of whitetails in the interior ranges should be proposed as a substitute for the public request to aid the deer with supplemental feeding programs.

Winter feeding is not an issue in the exterior (Kootenai County) now, nor should it be if the herds are properly managed. In Shoshone County, in the interior, due to heavier snowfalls, steep topography, present unfavorable range conditions, and the difficulty of getting adequate legal harvest, winter losses could be an ever present issue. Superficially Shoshone County appears different from the other areas where the public and Game officials have attempted to feed game in winter. Presumably it has a low population density of whitetails and an abundance of desirable food species in an area where severe winters are the exception rather than the rule. Actually, in view of the limited winter range for whitetails there can be competition for food when deer and elk numbers are up. Rapid disappearance of food as snows pile up creates a temporary and artificial shortage. Range surveys also indicate that very little of the available browse growth is classed as good forage.

What is not so obvious is that a complete absence of food seldom occurs and deer can survive a surprising length of time on short rations

in mild temperatures if left undisturbed. It is also disappointing to find that we are not always able to provide wild game with proper supplements for even short periods because we do not understand all the physiological problems involved. The final fact that feeding would be unwise for many reasons, even if we had excellent supplements, has caused many game departments to recommend that artificial feeding not be attempted. Allen (1950) sums up our problem as follows:

> The failure to interpret findings realistically or to publicize facts that run contrary to existing operational procedures probably accounts for the regular recurrence of unsound public demands.

Losses to parasites and disease. The occurrence of disease and parasitism are frequently noted and are often given undue emphasis in their relative effects in reducing game numbers. Parasitism is almost universal in wild animals and multiple parasitism is common. Dr. Ian McTaggart Cowan (1951) examined 150 big game animals of all species in Western Canada and did not find one that did not harbor some parasite. Seriously ill animals are seldom seen in the wild due to the difficulty of locating them, and the subsequent destruction of the carcass by carrion feeders (Figure 14). During critical winters or on depleted ranges the sick or parasitized animals frequently succumb to a combination of factors rather than to an individual cause. As a rule an animal in good physical condition on good range is a poor host for the parasites that might thrive on it were the animal undernourished. Even on over-used and crowded game ranges, parasitism and some diseases are considered secondary factors in animal mortality (Whitlock, 1939).

No detailed studies of parasites and diseases were conducted. Gross-examinations were made of all carcasses and specialists were consulted to identify diseased animals (Table 14).

Parasites. Many mature bull elk were lost on the Coeur d'Alene following the severe winter of 1949 before this study was under way. Forest Service and Game Department employees merely stated that they were "mangy" or "scabby." One old bull that died near Grizzly Creek (Figure 14) along the main river in December 1950, was examined by Dr. E. L. Cheatum, game pathologist, who identified it as having sarcoptic mange (Sarcoptes scabei). Since this is the only positive identification made to date, there remains some doubt as to whether the psoroptic scab mite or the sarcoptic mange mite, or both, are infesting local game animals, but the incidence is low.

The paralysis tick (Dermacentor andersoni) has been found on white-tailed deer in southern British Columbia and in northern Idaho, near Bonners Ferry; it is presumably a parasite of local whitetails. On the Coeur d'Alene Forest an examination of several hundred dead deer and two dozen elk failed to reveal even a moderately infested animal. One white-tailed deer had five engorged ticks on the neck and none were found on the elk.

Botfly larvae (Cephenemyia sp.) were recovered in limited numbers from the nose and throat of white-tailed deer and mule deer. One white-tailed doe autopsied during the 1936 winter study was thought to have died as a result of a heavy infestation of botfly larvae--59 of which were taken from the throat and sinuses (Brown, 1936).

In August 1953, nearly 150 adult white-tailed deer in nearby Spokane County, Washington, succumbed to a mysterious malady. Most of the victims were found in southern Spokane County and adjacent borders of Whitman and Lincoln Counties. The disease which started during the hot weather of late summer apparently subsided with the advent of cooler weather. The exact

source and nature of the disease, "black tongue," is not known, but it is believed to be carried by a blood-sucking louse or fly. It appeared to affect only the white-tailed deer in the one area. It is not known to affect humans or livestock.

Diseases. Pyogenic infections may be formed from bruises, injuries, pneumonia or tuberculosis. Several deer taken during each hunting season are deemed unfit for human consumption due to large pus sacs under the hide and in the joints, neck and body cavity. Perhaps much of this condition can be attributed to infections resulting from injuries and fighting since such type of injuries are more commonly found among the bucks.

The absence of molariform teeth, usually the first molar on the lower jaw, in several jaws recovered during spring loss checks, may be an indication of recovery from a slight attack of necrotic stomatitis (Actinomyces sp.). On the study area the incidence is apparently rare, perhaps due to lack of recognition by local investigators.

An analysis of material taken from a white-tailed doe that dropped dead in a corral trap at Farragut (January 29, 1950) was made at the School of Veterinary Medicine, Washington State College. They identified the causative organism as Corynebacterium ovis, a gram-positive bacillus that causes caseous lymphadenitis (pseudo-tuberculosis) in sheep. During the 1951-52 winter, four more cases were identified from deer collected at Farragut. During the 1953 fall hunt, 11 more infected deer were reported by hunters and Conservation Officers. Six of the 11 infected animals showed chronic conditions indicating the same ailment. They were as follows: A 2-year-old mule deer doe taken west of Coeur d'Alene near Blanchard; a 3-year-old mule deer buck taken at Bernard Peak directly south

of Farragut; a 7-year-old white-tailed doe taken near Black Lake in the Coeur d'Alene River Valley; a 10-year-old white-tailed doe shot at Chileo Mountain south of Farragut; a 10-year-old white-tailed doe shot at Farragut and a fawn white-tailed doe taken near Lakeview (opposite Farragut on the east shore of the Pend d'Oreille Lake). These deer were very thin with dark red, gelatinous bone marrow, as in winter starvation conditions.

Only six cases had been reported during the first three years of this study (1949-52), all from Farragut during winter and spring months. In five weeks of the 1953 hunting season six cases (two mule deer, four white-tailed deer) were reported, five of which were taken within 24 miles of Farragut.

Losses to accidents. Accidental injuries of game animals resulting in immediate death or by predisposing death to other causes, constitutes a steady and important drain on local herds. Eighty deaths were directly attributed to accidents during the period covered by this study, which amounted to 13.7 percent of all losses of white-tailed deer to causes other than hunting (Table 14). Crippled deer succumb more readily to predation, poaching, and starvation as well as to other accidents so that the total effect is difficult to assess. When hunting mortality is added, the losses to accidents comprises 9.1 percent of total recorded mortality.

During the winter of 1952-53, 15 white-tailed bucks, 15 white-tailed does, and two unidentified deer were killed, mostly by cars, in the vicinity of Coeur d'Alene. Of the 12 mature does, eight that were examined were each bearing twin fawns so the loss to the herd is considerably more than was indicated by doe loss alone. Heavy traffic along U.S. Highway 10 and U.S. Highway 95 takes a considerable toll of white-tailed deer as they cross the highways at night during all seasons of the year. The practice

of the State Highway Department of salting roadside berms to kill weeds may be attracting the deer also.

Other causes of losses to accidents are by drowning, falling from cliffs, being impaled on snags, crushed by falling trees, hit by trains, and entangled in wires. In the latter instance an unusual accident was discovered on the Magee District by a deer hunter in October 1953. An Army Air Force steel target tow cable that was shot away or dropped from a plane during World War II fell into the timber and brush at Miner's Creek. Four mature bull elk and a yearling elk were ensnared from 1950 to 1953 before the carcasses were discovered and the hazard removed.

Losses to predators. During the 1920's predators were listed as the most important limiting factor on herd increases (Table 1). Forest Service (U.S.F.S. 1921-58) estimates sometimes placed the annual loss to predators as high as 200 deer. With the opening up of roads into the interior in the 1930's, hunters removed more of the deer and predator control was initiated.

Primary losses to predation are tallied in Table 14. The Fish and Game Department maintains a predator trapper in northern Idaho. Due to the heavy timber cover, this area is generally not suitable for 1080 poison stations so cyanide guns, strychnine pills and traps are used. Deep, frequent snowfalls render trapping ineffective for much of the winter and poisoned baits are then used. About one Canada lynx is estimated taken in traps for every 50 bobcats, and 20 coyotes for every bobcat. The numbers removed by other methods can only be estimated and success is based on lack of predator sign or lack of complaints.

During the severe winters carrion has been so abundant that coyotes have not been forced to kill game. In many instances carcasses have re-

mained untouched because the predators had more feed than they could utilize. On the upper North Fork we have observed coyotes and coyote sign but in almost all cases they were several miles up-river from the deer ranges. Field evidence indicated the coyotes were hunting snowshoe hare, grouse and mice. Two does were run down on the river ice and killed by coyotes in January 1950, but the thaw late in the month removed the ice and no more kills were discovered. Many reports of predator kills were of game actually lost to other causes and the coyotes and bobcats were blamed. A fawn showing evidence of malnutrition was killed by coyotes on the Little North Fork road in March 1951. Fifty-two deer losses were attributed to predation during three seasons (Table 14) for 8.9 percent of the total recorded losses. Fifty records were obtained the first winter of the study.

The major losses to predators were on Coeur d'Alene Lake in Kootenai County during January and February (1949 and 1950) when the lake froze over (an unusual occurrence), and coyotes and dogs ran the deer out on the ice. Twenty-seven deer carcasses were found on the lake in one week in February, 1950. Predator control was hampered by the property owners who objected to the use of poison baits because of their dogs. These same people aggravated the situation by putting hay on the frozen lake to attract the deer and made predation much simpler (Figure 15).

Three carcasses showing evidence of bobcat use were examined during the winter and spring of 1950. In two instances the deer were probably killed by the cat but both deer had injured legs which presumably made them easy prey. The third deer was reported killed by a bobcat. Examination of the carcass and area revealed that this old buck had died a natural death and was consumed as carrion. Three bobcats were observed feeding on an old elk carcass at Pablo Creek on February 6, 1950, and a fourth, shot

later that day near Spring Creek by the author, had fed recently on a farmer's house cat. A bobcat shot near Fernan Lake during October 1953, was autopsied and its stomach contained seven field mice.

Cougar sign has been found in all parts of the Forest but nowhere is it abundant. An estimated 12-15 lions inhabit this million acre tract. Sight records have been reported at Tepee Summit, Prichard, Marray, Wallace, and Magee. No evidence of deer killed by cougar has been produced to date, although predation could occur in mule deer herds in isolated sections during the winter without our knowledge. The three cougar killed by elk and deer hunters in October 1952, were the first reported taken in many years. The amount of total mortality due to predation is 5.9 percent (Table 14).

The present predator control program appears to be unnecessary.

Losses to illegal killing. Winter die-offs and illegal killing of deer were proposed early in the investigation as the two most important factors limiting herd increases. The amount of illegal loss depends upon a definition of what is an illegal kill. For our purposes any game animal taken when a regular hunting season was not in progress was considered to be an illegal kill. There is much evidence of spotlighting, improper tagging, and similar violations during hunting seasons, but unless an arrest and conviction was made, they were not tallied as illegal kills but were entered in the legal harvest figures.

A survey of Forest Service records (1921-58) shows an increasing awareness by the rangers of the part played by illegal game killing in limiting herd increases (Table 1). The earliest records paid little mention to poaching. The plea then was to reduce predators in all forest districts except near the city of Coeur d'Alene.

Fig. 14. Many mature bull elk succumbed to various causes during the 1948-9-50 winters. Mange was commonly found in the older animals.

Fig. 15. Deer weakened by winter privations are easy victims to natural predators and feral dogs.

Prospectors and early miners had to kill game to survive in the rugged mountains in winter for roads were non-existent, and supplies had to be freighted in to the mining camps over rough trails during the short summer season. Sample quotes from early Forest Service records are -- "illegal hunting low" (1924) and "very little violations" (1930). By 1936 another note creeps in: "The deer are not increasing. Heavy hunting, legal and otherwise, is responsible", "Poaching on the planted elk is apparent." In 1945 "a heavy fall hunter kill and illegal kill" was recorded. "Illegal hunting can and must be remedied. . ." Contrast the 1924 report with a 1949 report: "Much of the annual increment of the deer and elk herds of this area continues to be lost to poachers." State Conservation officers blamed low numbers on excessive legal hunting but the ranger felt illegal killing was responsible.

The effects of the depression in the 1930's which closed many of the mines in the Coeur d'Alenes, and slowed other industries, was felt soon afterward on the game resources. The war-time boom in the early 1940's provided the local population with enough income to procure meat honestly, but domestic meat shortages and the general let-down in public attitudes toward violations were adverse factors in eliminating or controlling the illegal drain. Gas shortages did not curtail the road hunting for the main game ranges are readily accessible to the major towns. The influx of new workers and the return of many servicemen with generally high incomes, and an urge for recreational release served to markedly increase the number of hunters. Many of the new hunters quickly resorted to illegal hunting when it became obvious they could not kill game any other way.

Records of game poaching were obtained before the study was a month old and have continued throughout the study period. Detection of this type

of loss depends in part upon cooperation of the general public and fellow workers. Since some volunteer information can be misleading and inaccurate, much effort was made to verify the reports. In the field many evidences of illegal killing were found, ranging from the entire carcass to a pool of blood. Concentrations of deer at artificial feeding stations led to an increase in illegal killing. Records were obtained of violations during every calendar month of the year with the greatest incidence during February 1950, when heavy snows forced deer down along the river roads (Table 14).

The records were produced by Forest Service employees, Conservation Officers, biologists, ranchers, sportsmen, and other interested persons. In most of the cases the dead animals or parts were found. The only estimates involved were 56 whitetails reported killed in the ten miles between Eagle and Delta in mid-winter of 1950. Counts were made of blood spots and carcasses but they came so fast during our absences in that area that we relied upon the records of a local cooperator who travelled the road almost daily. He claims the figure was conservative.

Some areas such as Prichard Junction, are more accessible to violators and, with large deer concentrations, show more evidence of violations. Elsewhere the deer are scattered, which makes detection of illegal killing more difficult. The wider distribution of deer causes a dispersion of poachers and scattered evidence indicates that there is no area free from this menace. The incidence of illegal killing of game apparently depends upon the density of human population, the character of that population, the abundance and accessibility of game, the current public attitude toward game laws and the game department, the quality of local enforcement officers and judges, the type of publicity given to violations, and the

sentiment of local sportsmen's clubs.

From August 1, 1949, to September 1, 1951, 135 deer were known to have been killed illegelly on the study area (Table 14). It is impossible to estimate the total violations but this known figure almost equals the known legal hunter take of 157 whitetails for the same period. Table 15 provides a summary of the sex and age composition of the non-hunting mortality for 1949-50. Table 16 lists illegal losses as well as other causes, by sex, age and at monthly intervals as discovered.

Of the 304 deer lost by known causes in 1950, 95 were taken illegally (31 percent). This was the largest single drain on the herds but little mention was made of it by the public. A year later 40 deer were poached out of a known loss of 53 (75 percent). In 1952-53, with deer scattered widely as a result of the mild winter, 19 were reported as illegal kills out of 53 known casualties (36 percent). The total illegal kill of 154 deer for three seasons amounts to 17.5 percent of the known total mortality, including legal harvest removals. The Kellogg Chamber of Commerce finally went on public record condemning the reported increase of illegal killing of game along the North Fork following the heavy January snows (1954) ..."Not a week goes by without a violation..." For the first three years of the study, the over-all percentage loss directly attributable to illegal killing was 26.5 percent. If the deer lost to unknown causes are not considered, illegal killing constitutes 37.5 percent of all classified losses over a wide variety of conditions.

Summary of non-harvest mortality. Losses to all causes but hunting amount to 66.0 percent of the known total removal of deer to all causes. Thus it can be seen that two deer are wasted for every one harvested legally. No attempt was made to project crippling-loss as a mortality factor,

but if this were included, the legal harvest would be less than one-third of the total removel.

Losses to starvation have been covered in detail in a previous section of this study. It is not always possible to isolate the factors contributing to game losses, but it is known that animals weakened by starvation or old age often succumb to secondary infections, or parasitism. Disease and parasitism are not known to be important factors affecting survival of game animals on this Forest. The only exception might be the false tuberculosis which is commonly reported near Farragut. Heavy removals from this refuge by hunters, and cessation of trapping for purposes of transplanting diseased deer throughout the state should be effected.

Losses to accidents and predation increase during severe winters and may be increased when hungry, weakened deer are unable to cope with the difficult travel and feeding conditions. Elimination of hay feeding programs along the roads should reduce the accidental kills by cars, fences, dogs and wild predators, as well as the losses to poachers.

Known data regarding the illegal drain on white-tailed deer populations is believed to be conservative. The poacher takes the carcass and may be trying to hide the evidence, as contrasted to other types of losses. This constant attrition is considerable, probably averaging 5-10 percent of the total game populations annually.

Locally we have reason and evidence to believe that illegal killing is equally as important a factor in limiting herd increases as is legal hunting. Not only the total loss of game to violators but the possible differential rate of slaughter of fawns and does in winter along the river roads should be considered in calculating the annual mortality of the herds.

It is beyond the scope of this study to analyze all the factors in-

volved in game violations but since it is one of the largest single drains on the herds it should be more fully understood if proper management is to be achieved. The relatively heavy human population adjacent to the study area produces a large number of violations but there is no proof that the per capita rate exceeds that for the rest of the State. Interviews with self-pronounced violators, legal hunters, ranchers, and interested persons reveal many common attitudes and biases about this phase of the management problem. There is a hang-over of the pioneer spirit that the land and its resources are still available to anyone shrewd enough or tough enough to take them.

Legal deer hunting is not easy in this steep, heavily timbered country and, with hunter success averaging only 5-10 percent, there are many disappointed hunters each fall. Some people do not bear disappointment well and others refuse to, which frequently results in a game violation. Vdolators are as much of a cross-section of skillful and inept hunters as might be expected with legal hunters, so that generalizations about only poor quality hunters being the violators, or vice versa, are not justified.

Much of the hunting effort from 1949-52 was directed toward the more popular elk. Prior to 1949, elk had not been legally hunted and many local hunters felt they could be easily secured. A common reaction is that deer can always be taken later in the season with the advent of snows, or poached at any time. The small size of whitetails and the difficulty of getting the carcass out of the back country, are considered too great an obstacle to pursue them just for sporting values.

The Coeur d'Alene Forest also has many features to delight poachers--a wide variety and distribution of game species, thousands of miles of well distributed roads with numerous exits, plowed roads through winter game

ranges, and all within an hour's drive of the population centers. The bulk of the forest roads are open from June through November and at least half of the deer wintering areas are accessible all year long. The Forest receives heavy traffic at all seasons, which makes it unique when compared with similar game areas throughout the State. As is common elsewhere in the State, individual officers frequently have hundreds of square miles to patrol. Once apprehended, the violator seldom receives punishment severe enough to deter further infractions, and public censure of him or of the lax courts is seldom forthcoming.

Fig. 16. Coeur d'Alene Lake, south from Canfield Butte. Kootenai County game ranges are characterized by moderate terrain and climate. The many openings created by disturbances have been invaded by seral shrubs utilized by game as forage.

Fig. 17. The upper North Fork of the Coeur d'Alene River valley, south from Little Guard Peak. These dense coniferous forests provide limited winter forage for deer in Shoshone County.

THE HABITAT

Fire and Logging Effects on Vegetation

Vegetation is the one variable factor which ultimately determines the carrying capacity of a big game range. The natural succession of vegetation is normally determined by the topography, soils and climate. However, the impact of man has altered the normal successional pattern and disclimax species occur extensively throughout the Coeur d'Alene National Forest.

These changes in succession may be beneficial to deer in some cases and detrimental in others. The changes are due mostly to land treatment such as farming, logging, fires and mining. The successional pattern in this particular area is complex (Figure 6). The influence by any one particular change, whether natural or man-induced, cannot be entirely segregated from another as there is too much overlapping and repetition. Nevertheless, data on the physical features and climate, the general vegetational pattern and the amounts, kinds and intensities of various land treatments are presented in this report to reconstruct the ecological history of the deer winter ranges and point out what we may expect of them in the future. Fire and logging were found to be the major factors influencing vegetational succession on the study area.

The Lewis and Clark journals mentioned large burned areas in the Lochsa river region of northern Idaho (Thwaites, 1905). Some fire probably spread from Indian camps and signal fires, and some were purposely set to destroy the forests and encourage grass, especially in the subalpine fir type along the main Indian trails. White prospectors who were numerous

in many of the wilderness areas were very careless with fire and it was estimated that 35 percent of the Lochsa-Selway drainages were burned off by gold hunters (McCulloch, 1955).

Before 1908 in contrast, the records indicate that Kootenai and Shoshone Counties were almost entirely forested with mature stands of conifers. A few areas such as the open area near Trail Creek and Pony Gulch near Delta in Shoshone County were burned before 1900, but the exact cause and date were unknown. However since 1910, burns have covered approximately 150,000 acres (Figure 6) and the overlap of burns and reburns is very extensive.

These fires have greatly altered the aspect of portions of the Coeur d'Alene National Forest, especially in Shoshone County. However, there has been very little direct effect on the limited white-tailed deer winter ranges. A 1910 fire crossed the cedar flats above Prichard and burned out areas that had not been cut-over. The river bottoms of the main river and Tepee Creek above their junction were covered with mature timber before the 1910 burn. Adam Aulbach, writing in the Murray Sun in 1903, describes the area thus:

> There is fine timber everywhere, from the water's edge to the mountain's crest. On the bottom lands are large cedars, many of them measuring 30 feet in circumference near the ground. There is a lovely flat at what is known as Chicago Crossing, extending half a mile back. There is another at the mouth of Big Creek, but densely covered with timber. It is a glorious stream and a true sportsman's paradise.

Daubenmire (1945) has discussed changes in understory vegetation in north Idaho:

> Following logging or a devastating fire, ninebark, spirea, rose, snowberry, redstem ceanothus, willow, quaking aspen, and oceanspray may form heavy thickets which are ultimately replaced or reduced in height and density by the pine (in the ponderosa pine zone).

Stoddart and Smith (1943) in writing on the mountain brush type noted that:

> It extends far northward in scattered areas and mostly as a subclimax to coniferous forests, especially after burning... Northern coniferous forest lands after burning may remain for long periods in brush such as Symphoricarpos, Acer, Salix, Amelanchier, Prunus, Holodiscus and Ceanothus.

The most profound influence of the fires on the Coeur d'Alene Forest for wildlife has probably been to produce large acreages of elk and mule deer summer and winter ranges. Burning over the south and west exposure released an abundance of willow, serviceberry, redstem ceanothus and maple for winter game forage. Steep and open hillsides are more desirable as elk and mule deer habitat than they are for white-tailed deer.

Of the many disturbance factors altering the original forest vegetation, logging was believed to be one of the major influences contributing to the nature and quality of deer habitat. It has been an important industry for over 70 years with a pronounced influence on white-tailed deer winter range, either directly or indirectly. It is difficult at present to determine the pattern of the early logging on private lands. No records are available of when, where, and how they were cut.

By 1906 when the United States Forest Service took over the unpatented lands, most of the private lands had been or were being logged. Clear-cut logging and homesteading the bottom lands altered or destroyed much of the potential whitetail habitat but other ranges were created by opening up the virgin forests. After 1906 the Forest Service administered much of the cutting done in Kootenai and Shoshone Counties, although large tracts of forested lands were owned and administered by the larger logging companies.

Along the Coeur d'Alene River log production began to increase about 1903. During 1910 and 1911 logging was in full swing, soon reaching a

level which was maintained until the 1930's. During World War II, logging operations accelerated and as soon as men became available, the high post-war prices increased the output to its present peak. In 1952 and 1953, cutting first exceeded 70 million feet on national forest lands. From 1954 through 1958 the annual cut has averaged 74 million feet with an anticipated annual average of 100 million feet for the next 10 years. The total cut since 1907 is nearly two billion board feet with a valuation of $12,000,000.

Logging is of necessity tied in with many economic factors more important than deer food and cover improvement, as manipulation to serve that end alone is it expensive and (currently) unnecessary for game departments to become engaged in. The aim of this phase of the study then was to observe, measure and interpret changes in the understory vegetation on logged areas so as to be ready to suggest acceptable modifications in logging practices within existing economic and silvicultural limits.

Many workers have commented on the use of logging as a game management tool and various studies have been conducted, mostly in the eastern and Lake states. Graham (1954) noted that in Michigan, food for deer is provided in greatest quantities and quality in areas that have recently been logged, with upswings in deer numbers invariably following logging. In Maine, Gill (1956) stated that pulpwood cutting has now become a more important source of deer browse than land abandonment with its ultimate regrowth.

Webb (1948) in evaluating winter white-tailed deer ranges in the timbered mountainous portions of New York state showed that deer preferred good cover to good food and suggested logging as a technique for partially opening the stand and subsequently increasing the canopy where deer prefer to winter.

Basile (1954) in a deer range study on Moscow Mountain in northern Idaho recommended:

> ...that a number of clearings between one and two acres in size be made in the mid-tolerant tree stage of the cedar-hemlock zone to encourage shrub production and increase the carrying capacity. This will help to gain a wider distribution of the (deer) throughout the area.

Krefting (1956) stated that regrowth following cutting with an axe produced more new forage than when chemical sprays or fire was used to remove old growth.

Graham (1954) concluded:

> Clearly whitetails are dependent upon a combination of conditions that on any given area are transitory. Management of the deer herd depends upon our success in keeping a satisfactory proportion of the range in young conifers with recently cutover lands occupied by shrubs and young trees of suitable species. This can be accomplished silviculturally through successive logging operations, so spaced and arranged so as to form a pattern that will provide adjacent food and cover continuously . ...A diversity of age classes (small scattered cuts) will be of no avail unless species composition remains favorable.

The present study has demonstrated that succession following logging was probably the most important single factor influencing game range carrying capacity in the study region. Therefore, it was studied in detail. Seven locations in the interior in Shoshone County were selected in 1957 in grand fir types; three controls and four logged areas. A description of these areas is given in Table 20. Ten areas in the exterior in Kootenai County in Douglas fir types were studied in 1953 and a description of their location and logging histories is given in Table 24. One area was subsequently remeasured in 1957 and 1959 and a new area added in 1957. Maps showing the general location of the study areas with respect to the white-tailed deer winter ranges are presented in Figures 6 and 8. The vegetation on the logged areas and the uncut controls was analyzed by line transect sampling methods described under Techniques.

The studies that follow are discussed separately for Shoshone County (interior area) and Kootenai County (exterior area) due to the widely different vegetation types, topography, climate, and other factors that influence deer distribution and welfare (Figure 1).

The Forest Interior: Shoshone County

Earlier work by the Forest Service (Brown, 1936) delineated the major wintering areas for elk and deer on the Coeur d'Alene and portions of the adjacent Kaniksu Forest.

These areas are the valley floors, foothills, and south and west lower slopes for white-tailed deer, and higher south and west brushy and timbered slopes for elk and mule deer. However, the changes wrought by large fires have altered game use of some specific areas by destroying cover for whitetails and providing seral shrubs for mule deer and elk feed. In the vicinity of the Magee Ranger Station, whitetail populations which had declined following the 1931 fire, are slowly regaining their former numbers as the valley vegetation recovers.

The white-tailed deer ranges in the interior (Shoshone County) differ markedly from the foothill and valley ranges (Kootenai County) in climate, vegetation cover, snow depths, and total acreage. The large acreage is broken up into linear bands rather than large rectangular areas.

A major wintering area in Shoshone County is along the North Fork of the Coeur d'Alene River extending from near its source north of Magee to Kingston on Highway 10, a distance of approximately 70 miles. The main river and its tributaries winter big game from an estimated 400,000 acres of adjacent summer range. The area used varies with the severity of the winter and its minimum and maximum limits of use have been fairly well determined. The winter of 1949-50 (see Figures 10 and 11) may well

have been the most critical in recent history and the 1952-53 winter was one of the mildest on record for the lower valleys.

Six sub-units were selected in Shoshone County (Figure 8) and work centers located to cover the areas with winter surveys.

White-tailed deer range use

The winter of 1949-50 was severe, with persistent snows and cold weather. Deep snows of 36 to 60 inches limited the availability of forage and definitely restricted the choice of forage. On the river and creek bottoms much of the browse growth apparent in the summer was bent to the ground and covered by deep snows. Even on the treeless south and west exposures, the snow was continually deep enough to prevent pawing by deer or elk for the low-growing plants. The snow depth was reduced by a sudden three-day thaw and rain on January 20,21 and 22, 1950, after a -20° temperature on January 19. On January 23 the temperatures again plummeted from $+40^{\circ}$ to -17°. These temperature extremes are believed to be more of a factor influencing animal survival than are mean figures for a certain span of winter. The cold weather which followed crusted the snow so solidly that deer could move on top of it. This put them three to four feet above the ground and within reach of some feed which previously was too high. It also aided their movements in getting to new sources of food supplies. Within the mountainous portions of this study area the spring breakup was slow. On March 22 it was estimated that only 10 to 15 percent of the south exposures in the Little North Fork and the main river area up to Prichard were free of snow. This made a critical winter feed problem in this area lasting about three months. From Prichard

up to Flat Creek the critical [1] feeding period was 3½ to 4 months.

Actual over-utilization of available browse on whitetail ranges is apparent only in a few localized areas of the Coeur d'Alene Forest, especially the lower ten miles of the Little North Fork area. The lower mile of Beaver Creek and the lower two miles of Prichard Creek are used by heavy concentrations of deer with highlining of cedars and Douglas fir noticeable on the south bank of Prichard Creek. The principal problem on most ranges is the lack of available forage due to unfavorable plant composition, aggravated by the continual deep snows of the occasional severe winters. During the severest part of the 1949-50 winter there was a heavy concentration of whitetails from Flat Creek down through Long Pool Camp. The available food on the river bottom was limited. Before the late January thaw and freeze the deer depended mainly on the conifer and browse foliage hanging out over the river. Following that the deer worked up on the sidehills to get browse. With this large number of deer the available feed on the sidehills was used heavily for a short period.

Snows did not come early the winter of 1950-51 nor were they severe enough to cause restricted concentrations, except above Prichard on the North Fork. In Kootenai County snow depths were not over six inches for more than two or three days throughout the entire winter. Snow depths of 2-4 feet persisted for about six weeks during February and March in Shoshone County. White-tailed deer wintered quite widely however, and seemed to have little difficulty in obtaining food. Forest rangers estimated that there were about 70,000 acres of Forest Service lands used as white-tailed deer winter range which was about 32 percent of the range used by

[1] The use of the word "critical" in this study does not mean winter range in critical condition due to overuse but a period of deep snows and cold temperatures when survival is a critical problem for the deer.

deer summering on or adjacent to the National Forest. This is almost five times the area used in the previous winter of 1949-50.

The Deer Study was temporarily suspended during the 1951-52 winter so observations of Forest Service personnel are included here. They stated that in spite of the deep, early snows the big game wintered well. Streams and rivers froze over and the game travelled easily on the ice. White-tailed deer experienced some difficulty in foraging in three feet of snow along the river bottoms but thawing and crusting in early February permitted deer to travel on the snow surface. Lower slopes opened up in mid-March in the interior and deer moved out of the bottoms.

The 1952-53 winter was one of the mildest on record in the valleys with most of the precipitation coming as warm rains. At higher elevations snow accumulated to normal depths for the area and lasted later into the spring than it had following the severe winters of 1948-50. The deepest snow accumulation on white-tailed deer ranges occurred along the main North Fork between Camp Shoshone and Magee. In February it averaged 28 inches but surface crusting made travel easy for all classes of game. On Kootenai County white-tailed ranges, the ground was bare most of the winter so use of the range was determined more by animal habits than by severity of weather.

Over-lapping use of range and competition

Typical habitats for white-tailed deer, mule deer and elk occur on portions of the Coeur d'Alene Forest. Based on the observations of the winter of 1949-50 it appears that habitats for such game species are distinctly marked by individual cover type and terrain features. There seems to be only small, localized spots where over-lapping use of winter ranges by two or more big game species occurs.

Introduction of an elk herd on the burned-over areas does not crowd out whitetails as much as is often claimed. Whitetails decline as a result of fire itself which destroys essential cover. Elk numbers increase in response to the favorable range created after burning. It is not until the elk numbers get too large for existing ranges and crowd into timbered bottom lands to winter that they compete with the white-tailed deer. Hay-feeding programs have attracted elk also, with subsequent damage to already limited whitetail ranges.

Considering the winter ranges of all three big game species, that of the whitetail has received the most serious impact from civilization. The wide river bottoms which at one time supported dense stands of cedar and other conifers have been logged off almost completely; roads have been built on one or both sides of the main river drainage; ranching has become an important local industry and recreational use of the area is heavy. The habitat must be evaluated for its current potentialities, and future management will necessarily have to consider those cultural influences affecting whitetail range. There is competition between big game and current land uses in this area. For example, a proposed 290-foot dam at Enaville would flood 25 miles of valley bottom of the main North Fork upstream to Prichard, an area currently utilized by wintering whitetails. This would cause them to die, to migrate elsewhere, or to winter higher on the slopes which would bring them into direct competition with the hardier elk and mule deer.

Habitat selection and forage utilization

Deer in any habitat exercise a choice of cover and terrain. Observations of forage preferences of wintering deer, measurements of forage availability in winter and a description of the cover and terrain features

that seemed to be preferred are described below.

Availability. Game range surveys are generally made at a time of the year when the snows have disappeared and spring growth has commenced. Maximum figures are usually obtained whether the survey is aimed at composition and cover, or total availability. What happens to this volume of feed during severe winters has been speculated upon but no known previous studies had been made on the effect of snow in reducing availability. To relate snow depths to a known reduction in volume of available forage would be a valuable adjunct to the already known conditions of the winter range.

Snow has a definite limiting effect on the amount of winter browse available. The degree to which it affects forage is dependent on many factors, including form class of plants, type of snow, daily temperature fluctuation, wind, slope, aspect, and canopy cover.

Deep snows hinder game movement and bury low growing food. Wet snows bury low growing shrubs, but not species with an upright form. On the other hand, heavy snows sometimes increase the amount of some classes of forage by bending them down where game animals can reach them.

The extreme variability in snow conditions on various portions of the Forest in any year is further compounded by variations from day to day on the same site, and from one year to the next. For each portion of the game range, however, there are fairly adequate weather records indicating extremes in temperature and winter precipitation so that certain predictions can be made. A study was initiated in the fall of 1950 to measure the reduction in amounts of feed by various depths of snow on white-tailed deer winter ranges. The winter was only of average severity. Even though considerable snow fell in 1952-53, warm chinook winds and heavy rains

melted the snow very rapidly, preventing accumulation.

The results of this study have been reported in detail (Pengelly and Casebeer, 1949-51) and are summarized below:

Thirteen plots were analyzed, disregarding all variables except snow depth. Six to 12 inches of snow caused a decrease of 30 to 50 percent in the available browse. With 12 to 18 inches of snow, an average of about 50 percent of the browse was covered and unavailable. Eighteen to 24 inches of snow covered 50 to 66 percent of the vegetation. It would seem that with snow depths of 4-5 feet, which are common in the interior portion of the study area, the decreases of available food would be extremely critical. On the other hand, tree foliage and some browse over 7-feet tall would then be available. However, this would by no means compensate for the forage covered by the snow.

Basile (1954) encountered the same difficulties in getting adequate measurements during years of light or short lasting snow. He noted that tree canopy prevents snow from accumulating as deeply as in open brush types but protection from wind and sun causes it to melt slower. His study also showed differences in availability by species due to different branch growth habits. One to $1\frac{1}{2}$ feet of snow reduced availability of cedar by 43.2 percent to 45.8 percent; of rodstem ceanothus by 32.6 percent to 50.7 percent; and of willow by 2.9 percent to 7.2 percent.

The differences in snow depths that were observed between cover types are understandable, and the influencing factors, long recognized by watershed managers and workers in closely allied fields, have been summarized by Kittredge (1948). Interception and wind velocity, two of the main factors affecting snow accumulation, are dependent in large measure on the distribution and density of tree crowns and the size of the openings between

them. Kittredge reported that the accumulation of snow in the forest as compared with open areas is less directly under the crowns because of interception..., and greater in the openings because of reduced wind velocity. Edwards (1956) described large areas clear-cut and burned by loggers on Vancouver Island where black-tailed deer flourished. Heavy losses of deer were recorded during deep snow years which buried the forage and forced the deer to flounder.

The amount of snow on the ground at any time, however, is dependent not only on the snowfall that reaches the ground, but also on the losses due to evaporation and melting, which vary according to the occurrence and extent of condensation, radiation, humidity, rainfall, air exchange, and the soil.

Basile concluded that:

> Snow depths of as little as one foot may cause significant reduction in the amount of browse available to deer.
> Morton (1950) showed that 48 percent of the yield per acre of nine browse species occurred below the 1-foot level. The results of these studies all suggest that there may be a strong need to supplement forage inventories of big game winter ranges with information on average snow conditions and their effects on browse availability. Maintaining herd sizes at carrying capacities based on inventories that do not take into account the reductions in browse availability caused by snow can lead to seriously erroneous practices.

McCulloch (1955), in an elk study conducted on the Selway some 200 miles south and east of the Coeur d'Alenes in the winter of 1950-51, wrote on the problem of snow burial of forage,

> Snowstorms buried winter browse plants deeply and crusting rendered more browse unavailable during the greater part of the winter.... An estimated 40-50 percent of the 2000 tagged twigs were buried and unavailable during part of the winter.. All browse species were subject to snow burial. The species of spreading habit and weak stems, such as redstem ceanothus, snowberry, and ninebark were more susceptible than taller species such as willow.

An entirely separate but distinctly related problem is the influence of snow depth on deer use of an area. Whitetails will not use areas which have insufficient cover. They will, however, use heavy cover when forage is insufficient. Our observation that deer will starve in areas of heavy cover has been corroborated by Carter (1951). He found them selecting areas where snow depths were less than 15 inches, without regard for available forage. He further stated that snow depth was, after cover, the principal factor operating to limit winter range use by whitetails in western Montana.

Snow accumulation is influenced by exposure and cover. Cover indirectly affects snow depth and hence deer distribution, and conversely vegetative cover is largely dependent upon winter moisture conditions. Cover is also important for escape for whitetails along river bottoms, benches, and short steep slopes lower down.

Snow depths constitute a serious limiting factor for survival of white-tailed deer in the up-river part of the interior area by food limitation alone. Critical limitations of the available feed comes during the three to five months when the range is restricted to a narrow belt of river bottom and the movements of the animals are seriously hindered. White-tailed deer on good ranges can lose their maximum allowable weight loss in four or five weeks during severe winters and then wholesale losses occur (Severinghaus, 1947). Prolonging the concentration three to five months on fair-to-poor range would cause loss of the less hardy animals. This is the condition that was experienced during the 1948-49, and 1949-50 winters.

Palatability. Current usage of the term 'palatability' among game managers is reserved for the preference an animal shows for the individual plant species. Preference varies with abundance, associated species,

availability, by seasons, and with animal needs. For purposes of this study, good browse is considered that which deer readily choose in winter and which appears to be capable of sustaining life under ordinary wintering conditions. Lack of availability due to deep snow is not considered in the ratings assigned.

Poor browse species are those which are not usually eaten by deer under average winter conditions. It is not known whether deer could survive on these plants if forced to eat them. White-tailed deer are more likely to succumb to starvation than to resort to new forage species.

Previous work (Pengelly and Casebeer, 1949-51) has served as the basis for setting up palatability ratings (Table 18). Winters with little snow and low deer population pressure on many of the ranges during two of the three winters when the study was in progress prevented more detailed studies of forage use.

Top priority in food preference by whitetails on the study area would be red osier dogwood, western red cedar, redstem ceanothus, and serviceberry. Second food choices are maple, pachistima and willow. These seven species constitute the major portion of the winter diet. Oceanspray, ninebark, snowberry, and mock orange contribute little or nothing to the winter diet of deer yet they constitute over half of the available browse on winter ranges in the interior.

Table 18 is a comparison of two relative palatability ratings for the Coeur d'Alene area and for Lincoln County, Montana white-tailed deer ranges. The Montana ratings as described by Woolfolk (1952b), were a composite of values derived by the Forest Service in Regions One and Six, and by Montana State Fish and Game Department personnel engaged in the Lincoln County deer study near Libby.

Table 18. Relative palatability ratings for white-tailed deer forage; study area and Kootenai National Forest

Plant species	N. Idaho (Coeur d'Alene Forest) Pengelly and Casebeer (1949-51)	Brown (1936)	N.W. Montana Woolfolk (1952b)
Good Species			
Dogwood	1	1	-
Redstem ceanothus	1	1	1
Serviceberry	1	2	2
Western red cedar	1	3	-
Bearberry	2	4	-
Chokecherry	2	2	2
Douglas fir	2	4	4
Mountain maple	2	1	2
Oregon grape	2	3	2
Pachistima	2	2	4
Vaccinium	2	4	-
Willow	2	2	2
Poor Species			
Cascara	3	-	-
Grand fir	3	4	5
Hawthorn	3	3	-
Ponderosa pine	3	3	4
Rose	3	4	3
White pine	3	4	-
Alder	4	4	4
Cottonwood	4	4	-
Elderberry	4	4	-
Hemlock	4	4	-
Honeysuckle	4	4	4
Lodgepole pine	4	4	-
Menziesia	4	-	-
Ninebark	4	4	5
Oceanspray	4	4	4
Rubus	4	4	4
Snowberry	4	4	3
Spiraea	4	-	3
Syringa	4	4	2
Western larch	4	-	-

Rating Key:

1. Excellent or very good
2. Good
3. Fair
4. Poor
5. Very poor
   (not used in Idaho ratings)

Major differences in rating were noted in Douglas fir and pachistima which are rated as good in Idaho and poor in Montana, and in syringa which is rated as poor in Idaho and good in Montana. Minor differences are noted for fir, snowberry, spiraea, serviceberry, and ninebark. Dudley Brown (1936) listed lodgepole pine as being preferred to Douglas fir, whereas we rated it as poor forage and Douglas fir as good winter forage. He rated cedar as fair whereas we classed it as excellent. He also rated bearberry and vaccinium as of low palatability, perhaps basing his findings on lack of use due to low availability under deep snow conditions. In general, however, Brown's observations on species abundance and palatability as shown by deer preference, are in fairly close agreement with our findings.

After the observed preferences for forage and terrain are correlated with winter survival and general welfare of the herds, one may then write a description of the quality of existing ranges.

Winter range quality appraisals. Excellent white-tailed deer range. The desirable food species of browse (dogwood, willow, maple, serviceberry, chokecherry, redstem, ceanothus, cedar and Douglas fir reproduction) are predominant and well dispersed through the type. This will include some cedar in the canopy with some of its foliage available as food. There may be a broken canopy of conifer trees dispersed over the type with islands of dense canopy occurring occasionally. Some cottonwood is present in mixed age classes. The cover and food is interspersed quite evenly over the type so that one or the other can be used with a minimum amount of movement. It may include a narrow belt of hydrophytic species lacking the immediate canopy cover.

The most desirable types used during the critical period of the more

severe winters are usually the wide river and stream bottoms and bordering flats. The larger the flats, the more desirable the site. The above-listed cover type may also border on the lower edge of south and west facing slopes which are the only slopes with this cover.

Good white-tailed deer range. The composition may be quite similar to that described for "Excellent" but may have more severe condition of slope and exposure, or the apparent balance and interspersion of food and cover is less ideal. There may be a predominance of food species and the canopy can be very light or spotty. Or the canopy may be dense enough to limit the undergrowth to a light stand of desirable browse species. Some river bottom areas may have a predominant stand of cottonwood with an understory of desirable browse species, with a mixture of undersirable species. There may be a noticeable amount of undesirable browse interspersed with the desirable species.

These types are often the result of disturbance by logging, fire or cultural development. Old roads may leave openings which have grown up to browse furnishing food at the edge of dense timber. Some old burns on south or west exposures have left islands of timber. In these situations browse has come in to produce a great deal of food. There is usually a shortage of cover and in many cases such ranges have been taken over by elk.

Fair white-tailed deer range. Interspersion of food and cover is out of balance. Where cover is dense, desirable browse is sparse and if open patches occur they contain little desirable browse. In the more extensive open areas the desirable food species may occur only as remnants. The remainder may be open ground converted to cultivation, pastured heavily, or have grown up to less desirable species. In some cases these openings

may have a fair stand of cottonwood. Most larch-Douglas fir or white pine-grand fir stands which contain scattered browse plants on south and west exposures near river bottoms are of the "fair" type. Pole or mature stands of timber often contain scattered plants of desirable browse, especially if broken at all by partial logging. In some cut-over bottoms succession has apparently gone on through the stage of desirable browse species and into dense stands of non-desirable browse. Remnants of feed are left and cover is present. Past ranch use has eliminated food and cover in many river and creek bottom areas. Only border strips of browse and trees are left around most of these ranch sites.

Poor white-tailed deer range. Extensive timberstands of more than 70 percent density where the understory is either barren or herbaceous, or extensive open areas almost or totally devoid of a canopy cover are poor ranges. There may only be scattered patches or browse, mostly undesirable, or there may be extensive stands of desirable browse with no timber cover at all. Stands of dense hemlock are poor habitat. The only feed in such stands is usually found around the edges. Extensive rocky outcroppings are usually poor whitetail ranges.

Discussion. An ocular reconnaissance survey was made in the interior, in Shoshone County during the summer of 1950 and 70 linear miles of valley floor and foothill ranges were mapped and cover and density estimated. Each of the 113 areas typed was placed (Table 19) in one of the four quality classes described above.

In that portion of the main Coeur d'Alene River from Enaville to Flat Creek, 10,397 acres of white-tailed deer winter range were inventoried. In addition, 2,026 acres or about 16 percent of the winter range was classed as cultural waste, but this does not include the bulk of the roadways and

Table 19. A classification of white-tailed deer winter ranges; Shoshone County, 1950

Condition classes	Number of areas	Total acres	Percent of total minimum winter ranges	Average percent of understory cover	Average percent canopy
Excellent	1	256	2	20	60
Good	22	1,600	13	31	36
Fair	60	5,854	47	39	23
Poor	30	2,687	22	28	36
TOTAL (usable range)	113	10,397	84%		
(cultural waste)	73	2,026	16%		
TOTAL AREA		12,423	100%		

river channels which run through the range.

Only 256 acres, or 2 percent of the entire drainage was classed as excellent winter habitat for white-tailed deer. During the 1949-50 winter, an estimated herd of 250 white-tailed deer wintered in and adjacent to this unit on lower Prichard Creek. Each acre of this range supported one deer for the greater part of a very severe winter. The winter losses were very light compared to most other areas. The utilization of the vegetation was not excessive, but was more noticeable and more evenly distributed over this unit than on most other units. These factors were considered in classing it as "excellent."

Thirteen percent of the winter range was classed as "good." The densities on these units varied but generally there was more food and less desirable cover than occurred on the "excellent" unit. The desirable food

and cover species occurred in a high percentage of the types of this class but the undesirable species such as ninebark, oceanspray and hemlock also occurred in a high percentage of types.

Almost half (47 percent) of the winter ranges were classed as "fair." Variation in densities and composition was great in this class. An aggregate of the 60 units shows an increase in the density of "poor" browse over the "good" (41 percent) with a greater amount of undesirable species (59 percent). The canopy density is less with a large portion made up of over-mature browse species. There is no apparent significant difference in the occurrence of the species in the types classed as "fair" and "good."

The "poor" units made up 23 percent of the winter range. All these types were conspicuously lacking in either the desirable food species or cover species or both. However, the variation of densities and composition is much greater in this class than in any other.

The weighted computation for the entire usable winter range area indicated that less than half of the available shrubs are desirable food species and 30 percent of the understory is of the two most desirable species, serviceberry and dogwood (Pengelly and Casebeer, 1949-51). Ninebark, a poor forage species, occurs in 62 percent of the types and makes up 18 percent of all available browse. Oceanspray, equally poor, occurs in 75 percent of the types and makes up 14 percent of all available browse. Undesirable conifers and overmature browse makes up almost half (47 percent) of the total canopy on the winter range.

The general situation is that a very narrow winter range belt extends along the river and creek bottoms. It is composed of small units readily accessible to people, which results in continual disturbance and harass-

Table 20. Location and description of nine different-aged logged and unlogged grand fir areas; Shoshone County

Plot No.[a]	Name of area	Description and logging history	Measured
S 1	Little North Fork	River bottom - $\frac{1}{4}$-$\frac{1}{2}$ mile wide extending east-west direction for 10 miles. Limited homesteading. Timber canopy closing in. Logged since 1910. Peak of logging reached in 1920's.	1953 line intercept.
S 2	Prichard Creek	River bottom $\frac{1}{4}$-$\frac{1}{2}$ miles wide - dense timber on north facing slopes and bottom, scattered timber on south facing rocky slopes. Logged since 1890. Peak of logging reached by 1910.	1953 line intercept.
S 3	Downey Creek	Mature stand of larch, white pine, grand fir and hemlock. Uncut (control plot).	1957 line points
S 4	Downey Creek	SE. slope on steep face similar to #4 except recently cut. Logged in 1956-57, heavy partial cut to clean-cut (40-50 A.).	1957 line points
S 5	Ash Creek	Mature stand of timber (as #4) at highest elevation. Uncut (control plot).	1957 line points
S 6	Ash Creek	Same as #5 except cut and accidentally burned. 1 year and current clear-cut with 5-acre burn.	1957 line points
S 7	Ash Creek	Same as #5 except recently logged. 1 year and current clear-cut (unburned). (Whole area since burned by F.S.).	1957 line points
S 8	Jupiter Creek	SW. aspect. Mature stand larch, white pine, grand fir and hemlock. Uncut (control plot).	1957 line points
S 9	Jupiter Creek	SW. aspect - moderate slope. Similar to #9 except logged. Logged 1950 - heavy partial (40 acres) white pine and fir, hemlock.	1957 line points

[a]See figure 6 for plot locations.

ment of the deer. This harassment is a limiting factor in the maintenance of the white-tailed deer populations in the interior portion of the study area. The remaining winter range areas available for their use could, however, under proper management, produce more food and cover than currently is available.

Ecological effects of Logging

The ocular reconnaissance survey described above was followed in 1953 and 1957 by a series of line transect measurements on deer winter ranges and newly logged areas. Interior deer ranges in Shoshone County were sampled first because of the severe die-offs of white-tailed deer that have occurred in recent history. The locations are listed in Table 20 and the data presented in Tables 21, 22, and 26 - 31.

Little North Fork plots. The lower 10 miles of the Little North Fork drains eastward to the main river, providing steep south facing slopes for game use. This is an area of heavy snowfall and the timber cover of grand fir, white pine, Douglas fir, cedar and hemlock reflects the moisture conditions. Most of the sampling was conducted within 200 feet of the valley floor which lies at an elevation of approximately 2,200 feet.

Homesteaders in this area have cut timber intermittently for 60 years, but logging along the river was at its peak from 1920 to 1930. During the 1930's the area was well stocked with white-tailed deer, but numbers have been gradually declining, reaching a very low point following heavy die-offs in 1949 and 1950.

The 1950 range survey and winter loss checks on the Little North Fork indicated that this area is past its maximum productivity for deer forage. The excessive deer losses there in 1949 and 1950 were due to the fact that adequate forage does not exist for even a small herd of deer during diffi-

Table 21. Ground cover and botanical composition on two logged-over white-tailed deer winter ranges; Shoshone County, 1953 (all figures are percents)

Species	Little North Fork (S1) Logged 1910-30		Prichard Creek (S2) Logged 1890-1910	
	Ground cover	Botanical composition	Ground cover	Botanical composition
Good forage				
Dogwood	1.5	5.5	0.5	1.2
Vaccinium	0.7	2.9	0.2	0.5
Serviceberry	0.4	1.5	3.5	8.6
Cedar	0.3	1.1	0.1	0.3
Douglas-fir	0.3	1.1	1.9	4.7
Willow	0.2	0.7	4.0	9.9
Maple	0.1	0.3	0.8	2.0
Oregon grape	0.1	0.3	1.8	4.4
Bearberry	0	0	0.2	0.5
Chokecherry	0	0	0.4	1.0
Misc.	0.1	0.3	0.3	0.7
Subtotal	3.7%	13.7%	13.7%	33.8%
Poor forage				
Ninebark	7.0	25.4	1.1	2.7
Alder	5.2	19.2	1.8	4.4
Snowberry	2.8	10.3	17.3	42.6
Mock orange	2.4	8.9	2.4	5.9
Grand fir	2.3	8.5	1.2	3.0
Rose	1.1	4.1	0.2	0.5
Hemlock	1.0	4.0	0	0
Oceanspray	0.4	1.5	0.9	2.2
Misc.	1.2	4.4	2.0	4.9
Subtotal	23.4%	86.3%	26.9%	66.2%
TOTAL	27.1%	100.0%	40.6%	100.0%

cult winters. Thirty 100-foot line intercepts were measured in 1953 (Table 21) and they showed a total plant cover of 27.1 percent, of which only 3.7 percent could be classed as good forage. Tree reproduction and dense pole stands are crowding out the understory and undesirable species occupy six times as much space as does good forage. This range was classed as poor deer range in its present condition.

Prichard Creek plots. This east-west drainage (2500' elevation) was adjudged to be the best white-tailed deer wintering area examined in the interior area during the 1950 survey. The lower stretches of this area were cleared of big cedars from 1890 to 1910 and miners cut stull continuously from 1890 until about 1930. Some timber was also removed along the south side of the creek when the railroad was built to haul out the ore from Eagle and Murray before 1900. The area above Accident Gulch was logged from 1917 to 1924. This unit proved to be the only excellent winter range in the forest interior, apparently because of good moisture conditions due to heavy snowfall, and plant regeneration following the intermittent logging.

Thirty 100-foot transects (Table 21) yielded a total vegetative coverage of 40.6 percent of which 13.7 percent was classed as good forage. Despite deep snow conditions during the usual winter conditions, deer losses to all causes except poaching were light in this area.

1957 range observations. An extensive logging program to control insect-infested timber in drainages along the upper North Fork of the Coeur d'Alene River in Shoshone County was initiated in 1953 and continued through the duration of this study. By 1957 several large tracts (up to 700 acres) were clear-cut (Figure 18), presenting an opportunity to obtain measurements for comparison with previously logged areas and to learn some-

Fig. 18. A portion of the 700 acre sale at Ash Cr.-Beetle Cr. one year after clear-cutting to remove insect-infested timber. White-tailed deer winter along the river bottom and may use the edges of these lower slopes in the early stages of succession.

Fig. 19. Logging debris and steep slopes at the Downey Cr. sale-- a heavy partial cut at lower elevations near traditional white-tailed deer wintering areas.

thing about the rate and nature of plant succession on a different vegetative type. Since the logging is adjacent to limited game wintering ranges, such newly created forage areas provide an opportunity to evaluate game use. The location, name and a brief history of each of the seven new areas sampled are found in Table 20.

Two different-aged logging sites were measured at three locations; two areas were cut within the previous year and one was cut seven years previously. This provides an opportunity for the following analysis:

(a) Compare results of two "similar" areas and treatments and determine variability within these areas.

(b) Compare 1-year old cuts with adjacent uncut control areas to check changes occurring in understory composition and density in a short interval (1-year or less).

(c) Compare the 7-year old cut with its control and then with 1-year cuts to gain some insight into direction and rate of vegetational change.

(d) Compare overall results of successional changes induced by logging in grand fir-pachistima zones with that occurring in drier Douglas fir-ninebark zones.

(e) Compare an accidental burn in logging slash with cut and unburned cover, and with the adjacent control.

Downey Creek plots. Downey Creek, a tributary of the main North Fork drains northward from Grizzly Mountain and is an important elk hunting area. It was one of several areas being logged in 1956-57 and was selected for sampling (Figure 19). White-tailed deer winter in the lower reaches of this drainage near the main river and could conceivably winter higher if range conditions were improved.

A series of 910 point-plots were read in the recent cut on south and west facing slopes. Four hundred-twelve point-plots were read in the adjacent uncut stands as a control (Table 22). By comparison of the vegetation

of the control with that of the cut plot we should be able to detect changes due to logging.

Nineteen plant species were recorded on the two areas with 17 each on the recent cut and the adjacent control. In frequency percentage however, 7 of the 12 common species show statistically significant differences at the 95 percent level (Table 26). Logging apparently permitted an appreciable increase in rubus, maple, spiraea, and oceanspray and caused a decrease in pachistima, grand fir and white pine. There is a temporary loss in grand fir due to tree removal and in pachistima, due perhaps to logging damage. Rose, serviceberry, vaccinium, snowberry and mountain ash show no significant change due to the recent logging (Table 22). Good forage species decreased from 62.0 percent ground cover on the control to 50.0 percent on the 1-year logging. Poor forage species increased slightly from 29.8 percent ground cover to 33.1 percent (Table 22).

This may be due to the fact that the measurements occurred too soon after cutting to allow any appreciable influx of invaders to become established, or for those present to be released. The damage by logging machinery and presence of logging slash may be inhibiting to some species, yet favorable to others, by creating better seedbed conditions. In a shade-tolerant forest the profound ecological impact of complete canopy removal and soil disturbances appears to retard immediate response by forest sub-dominants.

Ash Creek plots. At the extreme western edge of the 700-acre Yellow Dog clear-cut area, at an elevation about 400 hundred feet higher than the Downey Creek plots and 600 feet above the valley floor, a series of plots was run in the adjacent uncut forest and in the recent cut on Ash Creek (Table 22 and Figure 18). A small accidental five-acre burn in the cut adjacent to the timber's edge was also sampled.

When all three areas are tested simultaneously (Table 29) there is significant difference at both the 95 and 99 percent levels for seven of the eight most abundant species.

Redstem ceanothus was not found in the control areas (S5) or unburned cut (S6) but an unusual number of seedlings were present in the small burned area (S7). According to Waters (1959), a light burn results in increased germination of certain seeds already present, whereas a heavier burn destroys humus and some buried seeds, but may expose other seeds and initiate germination. Light burns tend to favor invasion by windblown seeds such as willow and fireweed and heavier burns may favor establishment of heavier-seeded species. Burning also causes the acid soils developed under coniferous cover to become more basic with resultant adverse effects on understory vegetation adapted to acid soils. The removal of canopy and litter following logging and fire would also hasten leaching of surface minerals accumulated over long periods of time.

Pachistima and vaccinium decreased in the cut and disappeared in the burn (Table 22). The decline is less noticeable in the Ash Creek plots than in the recently logged Downey Creek plot (S4) and may be due to more favorable moisture conditions in the former. Rose was most abundant in the control area and least abundant in the burn. Snowberry was the only species not significantly affected by the treatments.

The invasion by lesser species such as rubus, Oregon grape, ocean-spray and spiraea is evident in this one-year period. Good forage species varied in ground coverage from 49.0 percent in the control area to 42.0 percent one year after logging and 24.0 percent in the burn. Poor forage species varied from 8.0 percent on the control area to 25.0 percent on the 1-year cut and 9.0 percent on the burn. Changes in species and density will probably be rapid in the next few years.

Jupiter Creek plots. The south facing slopes of Jupiter Creek were logged in 1950 and are currently (1959) being used by elk and whitetails in winter, although no game were ever known to winter there prior to 1954.

Fourteen different plant species were tallied (Table 22); 13 in the logged area and 11 in the uncut control. Although the difference in total number of species is not large nor significant, the difference in frequency is statistically significant. Of 10 common species tested, nine showed significant difference at the 95 percent level and six at the 99 percent level. Only grand fir showed no significant difference due to treatment (Table 30).

Good forage species increased from 19 percent to 30 percent ground cover with gains in Oregon grape and serviceberry while pachistima and vaccinium declined. This may be due in part to heavy elk use on the good forage in this isolated (newly created) wintering area which could have held the volume and density of these species down below their ability to spread and produce. Pachistima grows better in deep shade and may gain later as the canopy closes in.

Poor forage species increased from 27 percent to 42 percent ground cover with gains in spiraea, snowberry and rubus. Rose and hemlock declined in the 7-year logging plots.

Discussion. The most obvious feature of the grand fir type is that good forage is much more abundant than poor forage in all plots examined except the 7-year cut and control at Jupiter Creek. This is in sharp contrast to findings in the Douglas fir logging sites in Kootenai County.

Pachistima equals 39 percent of the botanical composition in uncut grand fir forests. This declines slightly to 37 percent on recently cut areas, which may be partly due to the crushing and burying effect of the

logging activity and the abundant slash. In the 7-year cut it is only 1 percent. Pachistima grows well in the shade and large openings are not favorable sites. As the associated vegetation grows and shades the ground it should be expected that pachistima will continue to spread until it reaches or exceeds the original coverage. Elk and deer feed heavily on it which could retard its spread but on the other hand, heavy snows bury pachistima early and may protect it from winter use.

Vaccinium is commonly found on old burns throughout the forest but the burn measured here was too recent to demonstrate this condition. No vaccinium was found in the recent burn. Again, elk use can be expected to influence its coverage in the 7-year cut. It is expected to increase as the burn grows older.

Redstem ceanothus was found in limited amounts on only the 7-year cut and in profusion on the recent cut and burn. Identification of the numerous seedlings in the ashes was difficult and missed completely at first, necessitating rerunning the plots. The fire evidently was necessary for proper germination. Waters (1959) in a series of controlled experiments in a similar vegetative type on the adjacent St. Joe Forest discovered that heavy seeds of redstem ceanothus become deeply buried under duff and humus and may lie dormant for many years. A ground fire removes the cover without damaging the seed. Exposure to the heat of the summer sun and nightly cooling cause fluctuations in seed temperature which cause the seeds to germinate.

Studies (U.S.F.S., 1957) on the Clearwater Forest showed a 1500 percent increase in estimated forage by weight in one year following clearcutting of over-mature shrubs, and there was an 8-foot coppice regrowth of willow in three months's time. In three years much of the new forage was

TABLE 22. COMPARISON OF GROUND COVERAGE OF COMMON PLANTS ON SEVEN LOGGED AND UNLOGGED GRAND FIR AREAS, SHOSHONE COUNTY: 1957 (ALL FIGURES ARE PERCENTS)

PLOT NUMBER AND AREA	(S3) DOWNEY CREEK CONTROL		(S4) DOWNEY CREEK 1-YEAR CUT[A]		(S5) ASH CR. CONTROL		(S6) ASH CR. 1-YEAR CUT		(S7) ASH CR. 1-YEAR CUT AND BURN		(S8) JUPITER CREEK CONTROL		(S9) JUPITER CREEK 7-YEAR CUT	
SPECIES	GROUND COVER	BOT. COMP.	GROUND COVER	BOT. COMP.	GROUND COVER	BOT. COMP.	GROUND COVER	BOT. COMP.	GROUND COVER	BOT. COMP.	GROUND COVER	BOT. COMP.	GROUND COVER	BOT. COMP.
GOOD FORAGE SPECIES														
PACHISTIMA	44.0	47.8	24.0	28.9-	34.0	59.6	30.0	44.8-	TR	TR-	4.0	8.7	1.0	1.4-
VACCINIUM	10.0	10.8	11.0	13.3+	15.0	26.3	7.0	10.5-	0	0-	9.0	19.5	5.0	6.9-
SERVICEBERRY	5.0	5.4	6.0	7.2+	TR	TR	1.0	1.3+	TR	TR-	2.0	4.3	6.0	8.3+
MOUNTAIN ASH	2.0	2.2	1.0	1.2-	0	0	0	0	0	0	0	0	0	0
MOUNTAIN MAPLE	1.0	1.1	8.0	9.6+	0	0	0	0	0	0	0	0	1.0	1.4+
OREGON GRAPE	TR	TR	TR	TR	TR	TR	4.0	6.0+	1.0	3.0-	4.0	8.7	14.0	19.4+
REDSTEM CEANOTHUS	0	0	0	0	0	0	0	0	23.0	69.7+	0	0	TR	TR+
SHINY CEANOTHUS	0	0	0	0	0	0	0	0	0	0	0	0	3.0	4.2+
SUBTOTAL	62.0	67.3	50.0	60.2	49.0	85.9	42.0	62.6	24.0	72.7	19.0	41.2	30.0	41.6
POOR FORAGE SPECIES														
GRAND FIR	9.0	9.9	3.0	3.6-	TR	TR	7.0	10.5+	0	0-	4.0	8.7	2.0	2.8+
WHITE PINE	7.0	7.7	1.0	1.2-	0	0	0	0	0	0	0	0	0	0
SPIRAEA	4.0	4.3	8.0	9.6+	TR	TR	5.0	7.6+	4.0	12.1+	1.0	2.2	10.0	13.9+
SNOWBERRY	3.0	3.3	3.0	3.6	TR	TR	1.0	1.3+	2.0	6.1+	4.0	8.7	14.0	19.4+
ROSE	3.0	3.3	3.0	3.6	8.0	14.0	6.0	9.0-	3.0	9.1-	10.0	21.7	6.0	8.3-
OCEANSPRAY	2.0	2.2	5.0	6.0+	TR	TR	1.0	1.3+	TR	TR-	1.0	2.2	1.0	1.4
HEMLOCK	1.0	1.1	1.0	1.2	0	0	0	0	0	0	6.0	13.2	0	0-
RUBUS	0.8	0.9	9.1	11.0+	TR	TR	5.0	7.6+	0	0	1.0	2.2	9.0	12.5+
SUBTOTAL	29.8	32.7	33.1	39.8	8.0	14.0	25.0	37.3	9.0	27.3	27.0	58.9	42.0	58.3
TOTAL	91.8	100.0	83.1	100.0	57.0	99.9	67.0	99.9	33.0	100.0	46.0	100.1	72.0	99.9

[A] A MINUS OR A PLUS SIGN IN COLUMNS S4, S6 AND S9 INDICATE A LOSS OR GAIN FOR THAT SPECIES FOLLOWING LOGGING. IN COLUMN S7 IT INDICATES CHANGES AFTER THE LOGGED AREA WAS ALSO BURNED.

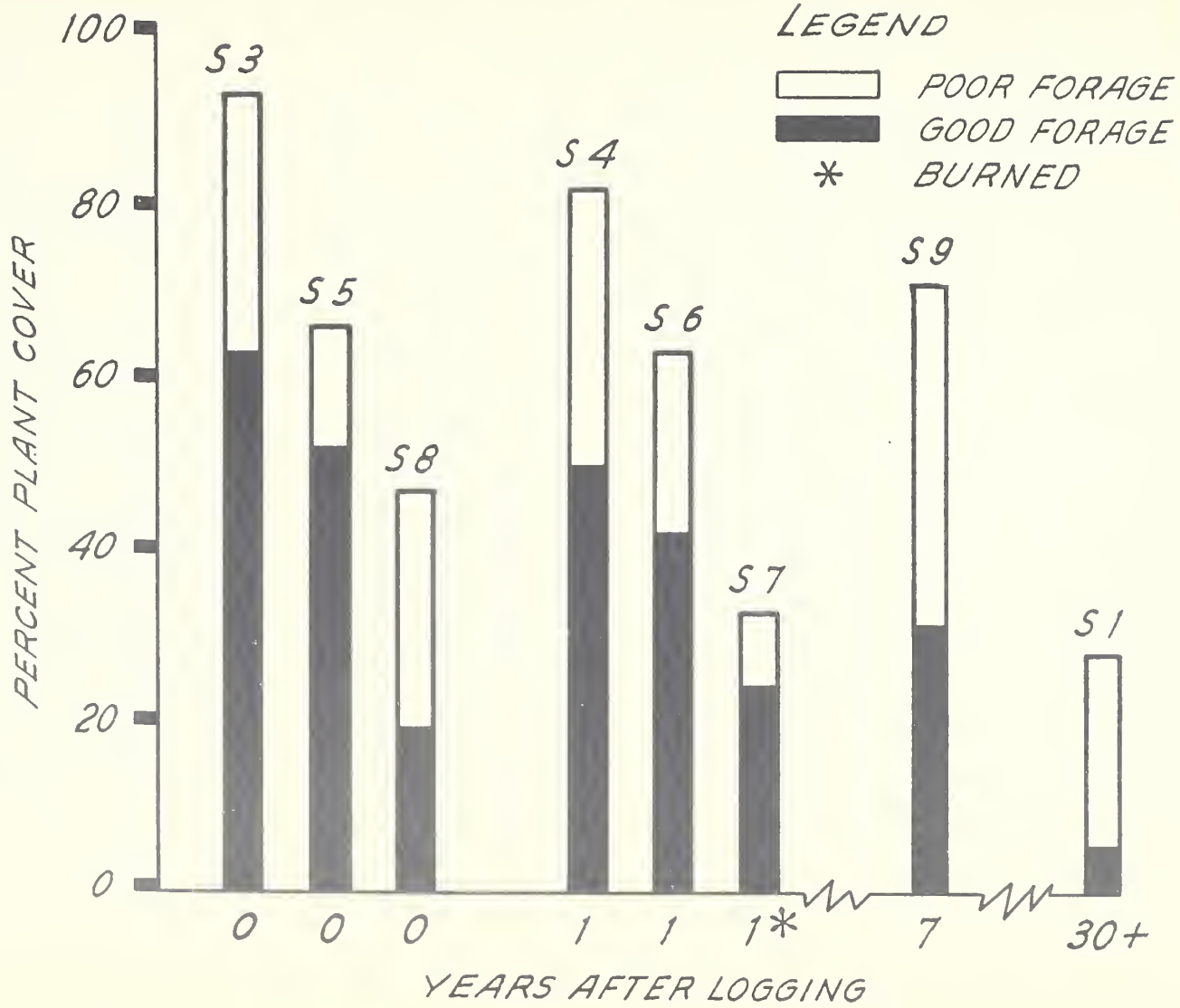

Fig. 20. Percent of plant cover before and after logging on grand fir sites, Shoshone County. Source: Table 22

again out of reach of game. Similarly it is predicted that the available forage produced as an aftermath of logging in grand fir types on this area will be quickly eliminated as the conifer canopy closes in.

Summary. White-tailed deer winter ranges are much more limited in Shoshone County in the interior than in Kootenai County in the exterior, due to more severe terrain and climate. Interior ranges have been destroyed by fires, suppression by shading of the conifer forest, and vital valley ranges preempted by human use.

Animal needs and preferences, and plant qualities are little known at present and can only be deduced from observations and experience. Ratings for the plant species present have been set up in the form of a palatability table on the basis of field studies. Four classes of white-tailed deer range have been established based on observed preferences correlated with game survival.

The recent logging in the grand fir climax can be counted on to produce temporary forage supplies but it is expected that elk and mule deer will profit more from this than will the white-tailed deer, because of the generally deeper snows, the lack of cover on clear-cuts, and their location high on the drainages.

The Forest Exterior: Kootenai County

The periphery of the forest, mainly along the south and west borders in Kootenai County (Figures 1 and 16) has less severe terrain and climate than exists in the interior, in Shoshone County (Figure 17). The plant cover is also different, reflecting warmer and drier conditions, and the land use pattern has also developed differently. These ranges extend from the southeast shore of Lake Pend Oreille in the Granite and Gold Creek drainages of th Kaniksu National Forest, south to the mouth of the Coeur

d'Alene River, and eastward along the gently rolling, south facing slopes between Coeur d'Alene Lake and the Shoshone County line near Cataldo. No range studies were conducted in the Bonner County (northern) portion of the study area.

Figure 6 is a location map and Table 23 summarizes the location, history and general features of each study area briefly. Sampling was done in areas that had never been disturbed, those that had been logged before 1900, and at intervals since in an attempt to detect direction and rate of successional change.

White-tailed deer winter in the foothills and flats from Rose Lake to Harrison along the Coeur d'Alene River, and from Harrison north to the Farragut Refuge on Pend Oreille Lake. In the severe winter of 1949-50 the minimum limits (Figure 8) of their use of these ranges was mapped and acreages computed (Pengelly and Casebeer, 1949-51). Critical feeding conditions lasted only about six weeks in 1950. During succeeding winters there has never been enough snow long enough to concentrate deer anywhere in the outer study area. Range studies were conducted in sub-units, 2,3 and 4 (Figure 8).

Sub-unit 2 consists of approximately 55,000 acres of winter deer range and extends from Farragut to the south end of Hayden Lake along the National Forest boundary during average or mild winters. Study plots K4, K5 and K7 are located within this sub-unit.

Sub-unit 3, from the south end of Hayden Lake to the Wolf Lodge area, consists of 29,453 acres of winter deer range. Study plots K6 and K9 were measured there.

The Harrison triangle, sub-unit 4, extends from Wolf Lodge south along the lake to the river at Harrison and includes the area north of the river

TABLE 23. LOCATION AND DESCRIPTION OF 10 DIFFERENT-AGED LOGGED AND UNLOGGED DOUGLAS FIR AREAS; KOOTENAI COUNTY

PLOT NO.[A]	NAME OF AREA	DESCRIPTION AND LOGGING HISTORY	MEASURED
K V	HORSE RIDGE	SOUTH AND WEST FACING TIMBERED BASIN, MATURE DOUGLAS FIR AND PONDEROSA PINE, SCATTERED SHRUB UNDERSTORY, 50% SLOPE, 3000' AVERAGE ELEVATION. USED BY DEER AND STOCK. NEVER LOGGED.	1953 LINE INTERCEPT
K 1	SKYLINE RIDGE	EAST-WEST RIDGE LYING NORTH OF MOUTH OF COEUR D'ALENE RIVER. DEER WINTERING AREA. CUT IN 1906 AND PARTIALLY RECUT IN 1951.	1953 LINE INTERCEPT
K 2	THOMPSON RIDGE	LOW TIMBERED RIDGE SLOPING GENTLY SOUTHWARD TO RIVER. CUT-OVER LANDS GRAZED BY STOCK AND GRADUALLY BEING CLEARED FOR HAY LANDS. DEER WINTERING AREA. HEAVY PARTIAL CUT IN 1946.	1957 LINE POINTS
K 3	HORSE RIDGE	ADJACENT TO KV ON SOUTH EDGE, 300' LOWER, 30% SLOPE. TREE REPRODUCTION AND DENSE SHRUB GROWTH COVER GROUND. DEER AND STOCK USE AREA. HEAVY PARTIAL CUT IN 1938.	1953 LINE INTERCEPT 1957 LINE POINTS 1959 LINE POINTS AND LINE INTER.
K 4	MOKIN'S CREEK	EAST-WEST RIDGES AT 2700' ELEVATION. ALL MATURE (18" UP) PINE AND FIR REMOVED.	1953 LINE INTERCEPT
K 5	JIM CREEK	HEAVY TREE AND SHRUB GROWTH. HEAVY PARTIAL CUT IN 1933 (BOTH AREAS).	
K 6	CAMP 8 DRAW	PATCHES OF UNEVEN-AGED CONIFERS AND SHRUBBY UNDERSTORY ON LOW ROLLING RIDGES. PRIVATELY OWNED AND GRAZED BY STOCK AND DEER. HEAVY PARTIAL CUT IN 1918.	1953 LINE INTERCEPT
K 7	FARRAGUT	SOUTH FACING GLACIAL MORAINE ON SHORE OF PEND OREILLE LAKE. NAVAL BASE CONVERTED TO DEER REFUGE SINCE WW II, 2400' ELEVATION, GENTLE SLOPE, LOGGED ABOUT 1912 WITH ILLEGAL CUTTING ABOUT 1926.	1953 LINE INTERCEPT
K 8	WARD RIDGE	SOUTH AND WEST FACING GENTLE SLOPES ADJACENT TO COEUR D'ALENE RIVER NEAR KILLARNEY LAKE, 2200-2500'. CONIFER REPRODUCTION, DENSE POLE STANDS AND SMALL MERCHANTABLE TIMBER, AND SCATTERED SHRUBS. AREA USED BY DEER AND STOCK. SELECTIVELY LOGGED ABOUT 1906.	1953 LINE INTERCEPT
K 9	CANFIELD BUTTE	FINE TIMBER AND WATER, HOMESTEADED EARLY. 2300-2800' SLOPES, ALL AGES OF TIMBER, SCATTERED SHRUBS. LOGGED PRIOR TO 1900 AND AGAIN IN 1923.	1953 LINE INTERCEPT

[A]SEE FIGURE 6 FOR PLOT LOCATIONS.

Fig. 21. A heavy partial cut of timber in 1938 at Horse Ridge was followed by a rapid and heavy invasion of shrubs which reached maximum development by 1953. Unpalatable shrubs (oceanspray in foreground) are dominant.

Fig. 22. Forty years after logging at Buttonhook Bay, Farragut, the timber is gradually closing in and eliminating the understory shrubs.

Fig. 23. Huge Douglas fir stumps in the lodgepole flats attest to the early climax status of the fir in the Rathdrum Prairie area prior to the 1906 logging and 1910 fires.

Fig. 24. Lodgepole pine invasion after the early fires and logging in the Bunko Flats area.

east of Rose Lake. A minimum of 38,600 acres (maximum 48,000) of deer winter range is available and five study plots (KV, K1, K2, K3, and K8) were located there.

Of the total of 132,000 acres of game range available in the exterior (Kootenai County) part of the study area during the average winter, it is estimated that 75 percent lies in the Douglas fir zone. All range sampling was confined to this major zone.

Ecological effects of logging

The range work was divided into two phases in Kootenai County--(a) an extensive sampling by 25,000 feet of line intercept in 1953 on nine different-aged logging sites used by deer in winter, and (b) remeasurements of one area (1957, 1959) to compare the line point method with line intercept, and to evaluate the successional changes occurring. One new area (K2) was added in 1957. Table 24 summarizes the species encountered in these 10 sites in the exterior foothill ranges of the study area. One area (K3) was measured at three different ages after logging (15, 19, 21 years) to trace the rate and nature of the successional changes.

1957 and 1959 range observations. Horse Ridge at Blue Lake (K3) was remeasured in 1957 and a new area (K2) across the valley on Thompson Ridge was measured for comparison, Thompson Ridge was logged in 1946, eight years after Horse Ridge.

Four 100-foot transects were measured in each area and the results, summarized in Table 24, are discussed below. Figure 22 is a graphic comparison summarizing the plant coverages occurring on all the different-aged Douglas fir logging sites sampled. Good and poor forage coverages are presented separately.

In 1959 the Horse Ridge plots were remeasured with 800 feet of line intercept and point plot data simultaneously recorded. This allowed comparison of the 1953 line intercept data with these recent data and gives a further check on the vegetational changes occurring from 1953-59.

On Horse Ridge, redstem ceanothus and oceanspray, the two most common species in 1953, showed a very decided change by 1957 and 1959, with the former species declining from a high of 30.7 percent plant coverage in 1953 to an average of about 7.5 percent in 1957-59 (Table 24). The overall average for redstem ceanothus for the measurements was 8.7 percent of the total plant cover. Oceanspray meanwhile increased from 24.9 percent plant cover in 1953 to 62.7 percent in 1957 and declined to 37.6 percent plant coverage in 1959. The overall average for oceansrray for the 12 measurements (Table 24) was 21.6 percent plant cover. Solid masses of mature oceanspray, 8-10 feet high, blanket large areas under the scattered Douglas fir canopy. The small firs left uncut in 1938 are putting on rapid growth and are crowiing out some of the understory shrubs, but competition between shrubs is also very intense.

Typically, in 1959, the overshaded redstem ceanothus plants presented an unthrifty appearance, with half or more of the stems dead. Unlike the broomed redstem ceanothus reported by McCulloch (1955) on the Selway elk ranges, these plants were being eliminated, not by overuse, but by shading and competition for moisture by dense stands of oceanspray and ninebark.

Thompson Ridge was selected for measurement in 1957 because it resembled Horse Ridge, except for age of logging (1946 vs. 1938). The vegetational changes that have occurred in the additional eight years, if the sites were closely similar, are: oceanspray--23 percent to 63 percent of the total ground cover on the older site; redstem ceanothus--4 percent to 5 percent,

total poor forage--78 percent to 88 percent, and good forage--22 percent to 12 percent. Differences in coverage caused by logging-age differences were significant at the 99 percent level for six of the seven common species (Table 34). Redstem ceanothus showed no significant difference on the two plots.

On the ten areas sampled in 1953-57-59 (Table 24), there was a total interception or coverage of all available browse for all the various aged logged and unlogged sites of 63.5 percent. This browse was composed of approximately 30 percent good, and 70 percent poor winter deer forage. Not one desirable species contributed more than 10 percent to the total volume of available forage. Three undesirable browse plants, oceanspray (21.6 percent), snowberry (19.5 percent) and ninebark (11.2 percent) totalled over half (52.3 percent) of the available forage encountered on the 12 areas measured.

The three most common good forage plants, redstem ceanothus (8.7 percent), service berry (7.0 percent), and chokecherry (4.1 percent), totalled less than one-fifth (19.8 percent) of the available plant cover on the 12 measurements. Thus it can be seen that nearly the same botanical composition ratio of good-to-poor forage exists using the three most abundant plants of each class (28.5:71.5 percent) as when all eight plants of each class (as in Table 27) are totalled (30.1:69:9 percent).

Discussion: The data tabulated in Table 24 and presented graphically in Figure 22 indicate a definite pattern of seral shrub succession following logging in the Douglas fir association.

In the unlogged forest (concerning the early history of which we can say nothing) shrubs cover about 22 percent of the ground area. By 11 years following logging, this has increased nearly fourfold, to 81 percent. The

TABLE 24. COMPARISON OF GROUND COVERAGE AND BOTANICAL COMPOSITION OF COMMON PLANTS ON TEN LOGGED AND UNLOGGED DOUGLAS-FIR AREAS; KOOTENAI COUNTY: 1953-57-59 (ALL FIGURES ARE PERCENTS)

PLOT NUMBER AND AREA	(KV) NO LOGGING		(K1) CUT 2 YEARS*		(K2) CUT 11 YEARS		(K3) CUT 15 YEARS		(K3) CUT 19 YEARS		(K4) AND (K5) CUT 20 YEARS				(K3) CUT 21 YEARS		(K6) CUT 35 YEARS		(K7) CUT 40 YEARS		(K8) CUT 45 YEARS		(K9) CUT 50+ YEARS		PERCENT OF TOTAL COVER
	GROUND COVER	BOT. COMP.	GROUND COVER	BOT. COMP.	GROUND COVER	BOT. COMP.	GROUND COVER	BOT. COMP.	GROUND COVER	BOT. COMP.	GROUND COVER	BOT. COMP.	GROUND COVER	BOT. COMP.	GROUND COVER	BOT. COMP.	GROUND COVER	BOT. COMP.	GROUND COVER	BOT. COMP.	GROUND COVER	BOT. COMP.	GROUND COVER	BOT. COMP.	
GOOD FORAGE SPECIES																									
REDSTEM CEANOTHUS	1.2	5.5	8.4	20.9	3.3	3.8	33.4	30.7	4.6	5.2	TR	0	1.3	1.8	8.5	10.0	11.5	19.8	0.1	0.2	0.7	1.5	1.6	4.7	8.7
SERVICEBERRY	1.2	5.5	2.6	6.5	10.1	12.7	2.9	2.7	2.7	3.0	2.8	4.0	2.0	2.7	3.4	3.9	14.2	24.6	4.0	7.4	3.2	6.9	1.5	4.4	7.0
CHOKECHERRY	1.9	8.6	0.2	0.5	TR	TR	5.2	4.9	2.2	2.4	2.1	3.0	1.3	1.8	2.0	2.3	1.2	1.9	0.5	0.9	9.4	20.3	0.8	2.3	4.1
DOUGLAS-FIR	0.5	2.2	0.1	0.2	1.2	1.4	1.8	1.6	1.5	1.8	4.4	6.3	6.9	9.5	2.9	3.4	1.6	2.8	1.7	3.1	1.0	2.2	2.3	6.7	3.3
OREGON GRAPE	0	0	0.7	1.7	0	0	0.9	0.8	0	0	1.0	1.5	0	0	0	0	2.4	4.2	4.5	8.3	3.9	8.4	0.7	2.0	2.2
MTN. MAPLE	0	0	1.2	3.0	0	0	2.5	2.3	0	0	1.8	2.6	0.3	0.4	0	0	2.5	4.3	2.4	4.5	0	0	0.6	1.8	1.6
VACCINIUM	2.0	9.1	0	0	0	0	3.8	3.6	0	0	0	0	0.3	0.4	0	0	0.5	0.9	0	0	2.0	4.3	0	0	1.5
WILLOW	0.2	0.9	0.3	0.7	3.0	3.7	1.9	1.7	TR	TR	1.2	1.7	2.3	3.1	2.4	2.8	1.0	1.8	0	0	0	0	0.4	1.2	1.5
MISC.	0	0	0	0	0	0	0.5	0.4	0	0	0	0	0	0	0	0	0.3	0.5	0.2	0.3	0	0	0.2	0.6	0.2
SUBTOTAL	7.0	31.8	13.5	33.5	17.6	21.6	52.9	48.9	11.0	12.4	13.3	19.1	14.4	19.7	19.2	22.4	35.2	60.8	13.4	24.7	20.2	43.6	8.1	23.7	30.1
POOR FORAGE SPECIES																									
OCEANSPRAY	0.6	2.8	6.4	15.9	18.6	23.1	24.2	24.9	55.5	62.7	9.0	12.8	11.1	15.2	31.6	37.6	5.3	9.2	17.1	31.6	4.2	9.1	5.3	15.4	21.6
SNOWBERRY	7.7	35.0	7.2	17.9	28.8	35.8	8.0	7.4	11.4	12.9	13.9	19.6	12.4	17.0	12.2	14.2	8.8	15.2	6.5	12.0	10.7	23.1	7.8	22.7	19.5
NINEBARK	0	0	6.4	15.9	0	0	4.2	3.8	3.8	4.3	12.6	18.0	22.0	30.1	13.4	15.5	3.2	5.5	12.5	23.1	0.7	1.5	5.9	17.2	11.2
ROSE	1.2	5.5	2.8	7.0	10.4	12.9	7.9	7.3	4.8	5.4	5.8	8.3	6.3	8.6	6.6	7.7	2.5	4.3	2.3	4.3	1.2	2.6	3.0	8.8	6.9
MOCK ORANGE	1.7	7.7	0	0	0	0	2.9	2.7	0	0	0.9	1.2	4.4	6.0	0.1	0.1	0.2	0.3	1.5	2.8	3.7	7.9	3.2	9.3	3.2
PONDEROSA PINE	1.5	6.6	1.8	4.3	0	0	1.8	1.6	1.0	1.1	1.0	1.5	1.5	2.1	2.3	2.7	0.2	0.3	0	0	3.7	7.9	0.3	0.9	2.4
SPIRAEA	2.3	10.6	0	0	3.0	3.7	0.8	0.7	1.0	1.1	0	0	0.4	0.5	0.8	0.9	1.7	2.9	0.8	1.5	2.0	4.3	0.1	0.3	2.2
GRAND FIR	0	0	0	0	2.0	2.4	0.6	0.5	TR	TR	7.0	10.0	0	0	0	0	0	0	0	0	0	0	0.4	1.2	1.2
MISC.	0	0	2.2	5.5	0.4	0.5	2.6	2.4	0	0	6.7	9.5	0.6	0.8	0	0	0.8	1.4	0	0	0	0	0.2	0.6	1.7
SUBTOTAL	15.0	68.2	26.8	66.5	63.2	78.4	55.9	51.3	77.5	87.5	56.9	80.9	58.7	80.3	67.0	77.7	22.7	39.1	40.7	75.3	26.2	56.4	26.2	76.4	69.9
TOTALS	22.0%		40.3%		80.0%		108.8%		87.5%		70.2%		73.1%		86.2%		57.9%		54.1%		46.4%		34.3%		100.0%

*PARTIALLY CUT IN 1906.

**THIS FIGURE WAS OBTAINED BY TOTALLING THE BOTANICAL COMPOSITION PERCENT VALUES FOR ALL 12 MEASUREMENTS; ASSUMING THAT THE THREE DIFFERENT-AGED K3 MEASUREMENTS WERE FOR THREE DIFFERENT AREAS.

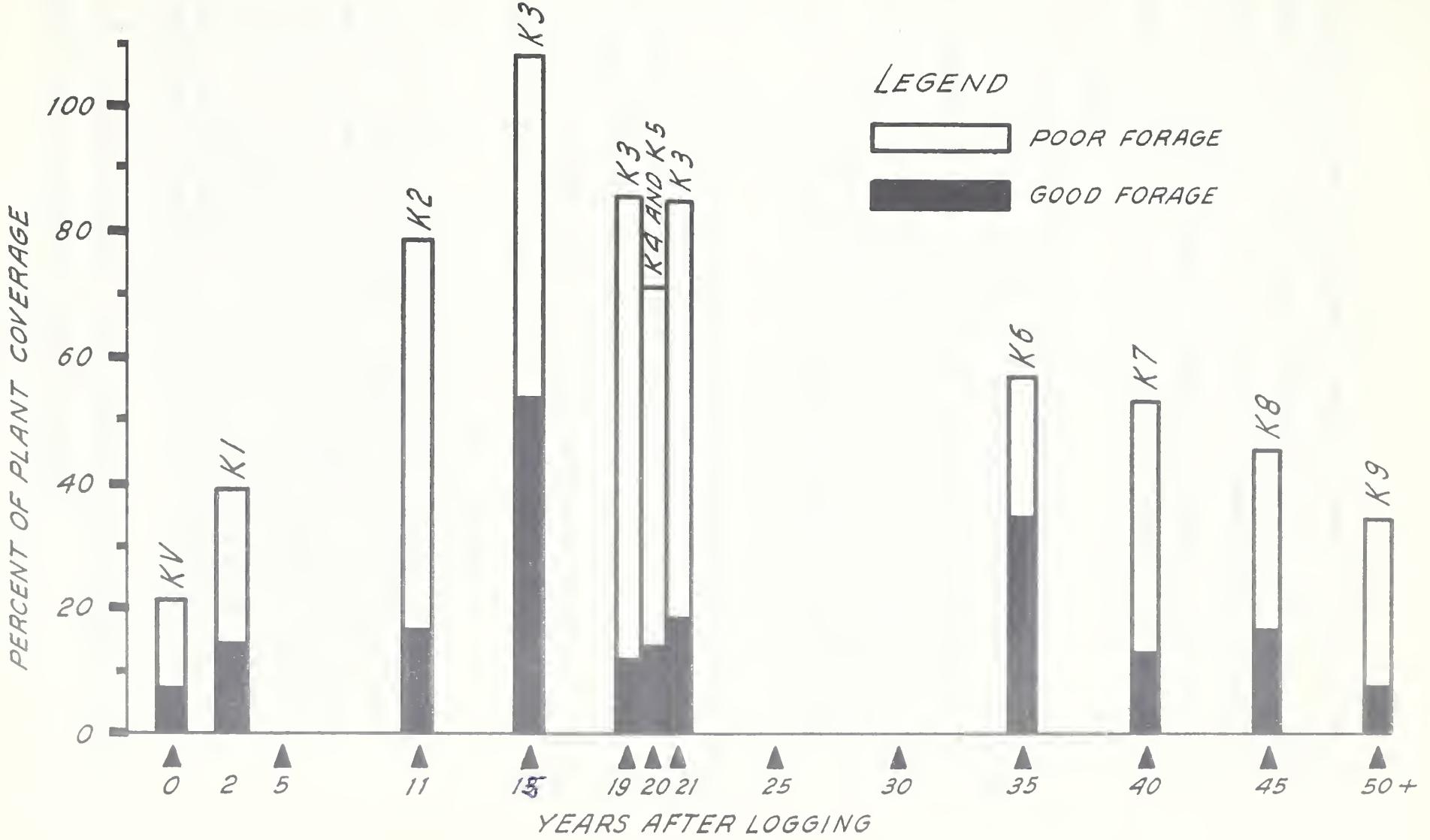

Fig. 25. Percent of plant cover on different-aged Douglas fir logging sites, Kootenai County, Idaho. Source: Table 24

peak of shrub abundance is apparently around 15 years when shrubs measured by line intercept totalled over 100 percent ground cover due to intermingling of the canopies. The same system of measurement indicated a decline to about 80 percent ground coverage by 20 years; 55 percent by 35-40 years; 40-45 percent by 45 years; and about 35 percent by 50 or more years following logging.

The relative proportions of good and poor forage species for each logging period are shown in Figure 25. As shown also, in Table 24, good species comprise less than half (30:70) as much of the ground cover in the unlogged forest as poor species do. By 15 years the proportion is about equal. Over the succeeding 30 years, the proportions by sampling vary from about 1:1 to 1:3 good to poor forage respectively, and average about 1:2.

Good forage is thus increased for about 30-40 years following logging, but the greatest abundance is found only 15 years after logging. It decreases rapidly thereafter. The data detailed in Table 24 illustrate also local variations probably due to intensity of deer stocking, as at Farragut, the undetected site differences.

Basile's (1954) work in Idaho raised this question:

> The proportion of vegetation comprised of shrubs is less in the tree stages of succession than it is in the shrub stages. This is a natural phenomenon. However, the decrease does not seem to be shared equally by all the species. Instead, the data suggest that as the vegetation approaches climax there is a marked downward trend in the percentage of shrubs comprised of species preferred as browse, with a concomitant opposite trend for the non-preferred species. Further studies directed toward the verification or rejection of this trend as a significant actuality should be of some assistance in evaluating the retardation of vegetational succession as a management measure for increasing browse production.

It would appear that this trend actually occurs, presumably due to competition between shrubs for light and moisture.

Interspersion of browse species within a type is nearly as important as is the total good forage available. Ingram (1931) in his work with sheep grazing on coastal Douglas fir cut-over regions, noted that on the newer areas where solid stands of fireweed predominated, the sheep became restless and trailed a good deal. They also utilized shrubs more closely in an evident effort to break the monotony of the diet, even taking unpalatable shrubs such as shiny ceanothus. As the number of palatable species increased, the total use became greater. This is probably as important a factor in use by deer.

Summary. Mature stands of Douglas fir and associated timber species on this study area are characterized by a very sparse shrub understory, except where local influences have created more favorable moisture conditions. Logging opens up the canopy and removes the competition by mature trees for the available moisture.

In contrast to the situation reported above for the succession in grand fir logged areas, seral shrubs come in rapidly and abundantly after Douglas fir types are logged reflecting, perhaps, the more intense moisture conflict on these drier sites. Native shrubs and invaders quickly respond to this more favorable condition and within 15 years after cutting in the Douglas fir-ninebark type there is a 500-600 percent increase in understory coverage of the common browse species at current deer stocking levels. When this forage is arbitrarily divided into good and poor forage classes it can be seen that within the total gain in coverage there is a definite pattern of gain for both classes, generally favoring dominance by poor forage species. After peak production at 15 years there follows a gradual decrease until only one-third of the ground is covered 50 or more years after logging, with poor forage twice as abundant as is the good

forage species. By extrapolation, one may predict that climax or sub-climax conditions will be again reached about 60-80 years after logging, depending somewhat upon site quality. The variability in pattern and composition now found is partly produced by the variation in the original understory in the forest, the character of the invading plants, and the intensity and frequency of the logging and fires in the area.

MANAGEMENT RECOMMENDATIONS

Many recommendations or suggested modifications in current management of the Coeur d'Alene white-tailed deer ranges and herds are obvious from a perusal of this study. Enough management data exist now to manage white-tailed deer more efficiently, and yet constantly changing conditions will require a constant effort on the part of the agencies involved to assess and adapt to these changes.

The reversion to solid timber cover on old burns, the shift into and out of seral shrub stages following logging, the impact of game populations on existing forage, the dynamic coactions of the game species, and the overlap of man's activities, both recreational and economic on this particular unit, should provide a real challenge to those entrusted with its proper care. Public support and cooperation should follow as the results of proper management become evident.

Opportunities for Habitat Management

White-tailed deer prefer definite combinations of terrain, cover, forage and temperature zone. These have been discussed in other sections of this report.

Logging and the road building for logging which has taken place in this Forest, have had important and often opposite influences on white-tailed deer winter ranges by reducing the winter range acreage, making the game more accessible at all seasons, and by opening up the stand to allow seral shrub dominance.

Usually the opening up of the pristine forest by fire and logging have benefited big game animals. When the profusion of shrubs and tree reproduction is allowed to grow out of reach and eventually to disappear as the forests again mature, the animal populations have been seen to shrink. In this study the ecological basis for this pattern has been worked out and described.

The inevitability of replacement of shrub species through succession toward climax is of utmost importance to the land manager since use by game or domestic stock cannot be indefinitely prolonged without intensive and expensive habitat treatment.

In addition, timber harvest cycles, cutting patterns and post-logging treatments have an important effect on seral forage shrub successions. Daubenmire (1952) states:

> Clearing with its sole objective to benefit wildlife is too expensive, but logging patterns can easily be modified to produce the same effect at very little additional cost. Selective cutting in the past has been not only silviculturally impractical in most of these forests, since seral trees cannot be regenerated in this way, but it is completely inadequate to provide openings large enough to favor wildlife. Logging blocks of timber, following by burning the same areas, may be the best general procedure to manage for both timber and wildlife production at altitudes above the ponderosa pine zone.

Timber management plans for the Coeur d'Alene National Forest are at present aimed toward harvesting large blocks of decadent, insect-infested timber in the forest interior. The stands will probably be clear-cut and burned, which favors immediate shrub growth. These block cuttings are ordinarily not on potential white-tailed deer ranges, but should benefit elk and mule deer populations.

Originally, most of the forest exterior was in private hands and was logged off before it was exchanged to Forest Service ownership. It is not sufficiently mature for a general second cut and probably will not be

harvested for at least another 20-40 years. The network of access roads is well developed and cutting will proceed only as small-scale salvage operations where conditions necessitate. Any intensive forestry will be practiced first on the more accessible areas and not necessarily where deer ranges need rehabilitation.

In 1952 the Forest Service sold two million feet of timber from western foothill ranges and one million feet in 1953, and estimated that private operators adjacent to the Forest sold about one million feet annually during the same period. It is doubtful that even 10,000 feet per acres is realized from logging of the exterior timbered lands. At most then, little more than 300 acres are being cut-over annually on the peripheral game ranges which are estimated at 132,000 acres. This manipulation will probably not prove adequate in providing a constant source of uneven-aged game forage to accomodate the deer populations that are building up in the valley.

On the basis of this survey it can be said that the peak of browse production on white-tailed deer ranges is generally past on Douglas fir sites in the exterior portions of this study area. Poor browse species occupy over twice (70:30) as much space as does good forage on the average of all Douglas fir logging areas surveyed. Plans for increasing white-tailed deer on these ranges should be based on the understanding that occasionally, severe winter conditions will also bury existing feed, impede travel and increase the animals' needs.

The logical time to attempt selective reduction of poor forage species by spray or mechanical means would be when the good forage is making its greatest increase, about 10-15 years following logging. One undesirable shrub, oceanspray, provides the greatest volume at most ages of

logging, and steps to retard it are warranted where increased good browse production is desired. Small scale experiments in selective reduction should be initiated in advance of the need.

At 30-40 years after logging, conifers are making their greatest increase and tend to crowd out understory shrubs. Timber stand improvement in the form of thinnings and Christmas tree sales might be used in combination with selective spraying to delay the decline of favored deer forage species. At about 100 years, the timber stands open their canopies which encourages the growth of shrubs and tree reproduction.

In grand fir timber types on the other hand, logging appears to have only limited possibilities for producing or improving white-tailed deer winter ranges. When the canopy is unbroken, deep snows remaining on the ground for many months discourage white-tailed deer use of the area. The cover is excellent but cover shortage is not a problem. When the canopy is opened by logging, less snow is intercepted and more falls to the ground, burying spreading shrubs. While the snow melts earlier in the spring under a more open canopy, the forage is usually unavailable in the mid-winter period when it is most needed.

The indicated changes in understory composition and density in grand fir cuts are not as great as occur in logged-over Douglas fir sites. In addition, large openings are shunned by white-tailed deer, especially so in deep snow areas at the higher elevations. Small block cuts which would be more useful to deer are not currently being used in the removal of insect-infested timber and are uneconomical due to the high costs of road construction and hauling. Recently, however, there has been much interest shown by small operators in the small salvage-sale program on the Kingston district. In addition, sanitation cuts or blowdowns of old hem-

lock stands, and accidental small burns near already existing wintering areas, may improve white-tailed deer winter ranges at the lower elevations.

The opportunity for deer winter range improvement through timber sales is limited by the existing age classes of available timber and the current market, which causes variations in what constitutes merchantable age. Some of the older timber stands in Shoshone County will not be merchantable until the year 2,000.

The details of game habitat manipulation have been suggested in the Wildlife Management Handbook (Region I, U.S. Forest Service 1957). It is suggested that local habitat manipulation details be worked out between forest rangers; fire, watershed and range researchers; and game biologists.

Fire has been an important ecological factor in the forest interior and exterior in the past. Natural restocking of large, hot burns, has been very slow, especially on the shallow, rocky soils of drier south and west exposures. After burning the site is dominated for two to five years by herbaceous growth. A mixed variety of shrub species then invades and may flourish for 30 to 60 years before timber species effectively compete. These shrub species include willow, maple, serviceberry, chokecherry, redstem ceanothus, oceanspray and ninebark; all but the latter two are good game forage.

Removal of slash and other logging debris by broadcast burning, rather than bulldozing slash into poles and burning it, would foster heavier initial stands of preferred forage. From our limited observations it would appear that the fertilizing effect of light single burns create a very favorable mixture of preferred forage species for white-tailed deer for a period of 5 to 30 years. Small burned areas are preferred by white-tailed deer. Larger and more open areas are used by elk, and often mule-deer.

The Interior: Shoshone County

This area is marginal for white-tailed deer in winter due to a generally unfavorable combination of climate, terrain, and plant composition. The already limited areas of suitable range are being further reduced by timber growth, roads, ranches, and are threatened by future prospects of a large dam on the North Fork. Perpetuation of whitetails can be assured only by:

(a) Development of winter game ranges by logging, properly timed and located. Ranger-directed sales of 10-40 acres in areas of good cover but poor forage are indicated. Slash should be removed by broadcast burning.

(b) Control of elk members on over-lapping ranges.

(c) Effective law enforcement, especially during winter months, to control the constant and selective attrition on small, scattered herds due to poaching.

(d) Enlistment of public aid to emphasize the need for more adequate legal harvest and to change current attitudes toward violators.

(e) Organizing of counts of whitetails in key areas during every severe winter, to be followed by spring loss checks. Public air should be solicited.

(f) Discouragement of supplemental feeding of deer.

(g) Establishment of checking stations, whenever possible, to obtain more management information and to improve public relations. Weekend stations at Enaville and Dobson Pass would produce the most information for the least expense. Hunter-questionnaire by card survey should be continued and results correlated with station records.

(h) Continuation of forage inventories with special reference to

changes occurring inthe newly logged areas. Standard range techniques using permanent line-point transects, photo plot records, utilization checks, and small exclosures to isolate effects of game use from natural successional changes, should be employed. The effects of clear-cuts vs. partial cuts; of large block cuts vs. smaller cuts (square vs. retangular); and broadcast burning vs. lopping and scattering; need to be determined for each major forest association.

(i) Continuation of studies of relation of snow depth to deer distribution and survival, and forage availability. These studies need to be correlated with timber age class, crown densities, and deer behavior to determine future modifications in cover manipulation.

(j) Education of the public with regard to the potential for white-tailed deer management. Future seasons should be determined on the basis of rational decisions, not emotion or tradition. A heavier harvest could safely be achieved with later seasons, extensions, or 2-deer harvests to shift the removals away from illegal killing and winter losses. If the public is given the choice and decides upon the latter, more wasteful approach, then the management agencies' responsibility is made more difficult. It is not the "will of the people" until they have heard both sides and made their choice.

(k) Emphasis on mule deer and elk, which are important game animals in their own right. The greater adaptability of these species to existing cover, forage, and snow conditions fits them well for conditions in the forest interior. Elk are at present the most popular and hardy game animal in the county. Also they are potentially more of a hazard to the forage than the smaller deer if their numbers are not carefully controlled. The logging in the up-river areas may produce larger elk populations to

the detriment of both species of deer.

The Exterior: Kootenai County

The broad valleys and foothill ranges of Kootenai County, in contrast to the situation in the forest interior, favor white-tailed deer survival. Mild climate and abundant escape cover more than compensate for the generally unfavorable plant composition. While the carrying capacity per acre for deer may be low, there are many acres available. Proper management of whitetails in Kootenai County should include:

(a) Careful control of hunting pressure, especially in winters of early snows. However, necessary herd removals could be effected by provision of an extended season in December. This measure is subject to abuse, since locally the public amy refuse to hunt if early snows fail to occur.

(b) Control of elk herds along the foothill ranges of Kootenai County. The possibilities for depredation are much greater here and available forage should be dedicated to deer use.

(c) Application of recommendations listed for Shoshone County regarding increased law enforcement, public support against violators, forage inventories, winter counts and fall harvest checks.

(d) Continuation of range studies to investigate and use of chemical sprays in retarding unfavorable succession on Douglas fir logging sites.

(e) Clarification of the status of mule deer herds along the foothill and mountainous portions of Kootenai County. They are apparently increasing as a result of protection, favorable ranges, low hunter take, and a series of easy winters. No special management procedures can be recommended at this time except to continue to gather data regarding their

numbers, losses, and ranges as the opportunity arises.

Public Relations

We speak of the deer problem when in reality we may mean the human relations problem. An effective educational program to serve all age levels should be sponsored to acquaint more people with facts of management. Only then will they understand the problems involved. They need to become part of the answer and not part of the dilemma; they also need to know the possibilities for better management and what it takes to gather the information and to put the program into effect. Science can only go so far, the public will have to want to put the findings into practice and this will require mature, sincere leadership on the part of agency personnel, using effective techniques for communication.

Conversely, we have relied too long on empiricism. We judge our success by how few complaints we get, by how much game the hunters bag, and by the continued presence of certain game species; these are accepted or offered as proof that we are doing a good job. This viewpoint is expressed by Hickie (1957):

> Unfortunately, wildlife conditions change and when things go violently wrong, empiricism is likely to be inadequate; hence study is recommended to uncover some new 'wonder drug' to cure the difficulties.

If the management suggestions listed above are carried out, big game animals can be a product of these forest areas for generations to come. There is at present no serious biological obstacle to the complete integration of timber and big game production in this area. The principal remaining unsolved problems are sociological. Without public support no effective program can be long continued in a democracy. Future plans, therefore, should include not only a study of biological factors and

efficient management, but also provide for the continual education of the public.

SUMMARY

A field study of white-tailed deer was conducted intermittently over a 10-year period (1949-59) on the Coeur d'Alene National Forest in northern Idaho. The vegetation, climate, geology, history, big game populations and the methods of study are described.

The objectives were to analyze the environmental factors affecting the abundance and distribution of white-tailed deer, and to study the effects of logging on seral shrub stages in two timber associations.

Estimates of white-tailed deer populations on the study area from 1921-58 indicate a 600 percent increase (400-2400), despite temporary setbacks suffered following three severe die-offs (1932-49-50) and three minor starvation losses (1927-43-45) in the interior. Additional losses to constant illegal killing, legal harvests, predation, and accidents have always been recuperated and the herds have been seen to increase. Available productivity data indicate normal or above average production for this species over the whole study area.

Shoshone County herds are subject to occasional heavy winter mortality. Also they are difficult to harvest. A shift in game management emphasis to the hardier mule deer and elk is indicated.

Whitetails in Kootenai County suffer little winter mortality. However occasional heavy early snows move the deer to areas easily accessible to hunters, and over-harvesting is possible. Management emphasis can well be maintained on whiteails on the foothill ranges of the exterior.

The apparent demand by white-tailed deer for wintering areas along

valley bottoms for acceptable forage and for adequate cover is, in effect, a self-imposed set of limiting factors. By the very nature of the marginal environmental conditions for white-tailed deer in the study area, their past and present management is characterized by inefficiency. It is the current management aim to reduce that inefficiency. Careful herd control and attempts to provide proper forage and cover combinations by habitat manipulation are suggested.

Since 1880 fires and logging have altered the general aspect of the virgin coniferous forests of northern Idaho to a diverse admixture of mature timber remnants, second growth timber reproduction and pole stands, and brushfields of varying sizes. The seral shrubs in the forest understory and clearings in many areas are important as winter range for white-tailed deer.

Logging is the most effective and least expensive habitat management tool at the disposition of the game manager in the study area. The current disparity between the apparent economic values of the timber resource and the indefinite value of game will preclude logging designed specifically to aid game for some time to come. Slash disposal by broadcast burning is recommended following logging.

Plant succession can be altered by logging and fires to produce temporary increases of forage acceptable to deer. The peak of forage production on Douglas fir sites is reached 10-15 years after logging and then gradually declines, with poor forage gaining dominance in the understory composition. Logging on grand fir sites has less potential for improving whitetail winter ranges. Suggestions for prolonging the seral stages by selective chemical spraying and timber stand improvements are included in this report.

APPENDIX

Appendix A. Scientific Names of Plants and Animals

Important plant species

Common name	Scientific name (after Davis, 1952)
Trees	
Grand fir	Abies grandis
Sub-alpine fir	Abies lasiocarpa
Western larch	Larix occidentalis
Englemann spruce	Picea engelmanni
Lodgepole pine	Pinus contorta var. murrayana
Western white pine	Pinus monticola
Ponderosa pine	Pinus ponderosa
Douglas fir	Pseudotsuga menziesii
Western yew	Taxus brevifolia
Western red cedar	Thuja plicata
Western hemlock	Tsuga heterophylla
Black cottonwood	Populus trichocarpa
Aspen	Populus tremuloides
Shrubby plants	
Mountain maple	Acer glabrum
River alder	Alnus tenuifolia
Serviceberry	Amelanchier alnifolia
Kinnikinnick	Arctostaphylos uva-ursi
Oregon grape	Berberis repens
Western paper birch	Betula papyrifera
Redstem ceanothus (Buckbrush)	Ceanothus sanguineus
Snowbrush	Ceanothus velutinus
Dogwood	Cornus stolonifera
Hawthorn	Crataegus douglasii
Oceanspray	Holodiscus discolor
Honeysuckle	Lonicera spp.
Menziesia	Menziesia glabella
Mountain lover	Pachistima myrsinites
Mock orange	Philadelphus lewisii
Ninebark	Physocarpus malvaceus
Chokecherry	Prunus virginiana var. melanocarpa
Pin cherry	Prunus emarginata
Cascara	Rhamnus purshiana
Currant	Ribes spp.
Rose	Rosa spp.

Shrubby plants (continued)

Thimbleberry	Rubus parviflorus
Raspberry	Rubus spp.
Willow	Salix spp.
Elderberry	Sambucus glauca
Mountain ash	Sorbus scopulina
Spiraea	Spiraea betulifolia
Snowberry	Symphoricarpos albus
Dwarf huckleberry	Vaccinium caespitosum
Huckleberry	Vaccinium membranaceum

Grasses

Bluebunch wheatgrass	Agropyron spicatum
Redtop	Agrostis alba
Mountain brome	Bromus carinatus
Cheatgrass	Bromus tectorum
Pinegrass	Calamagrostis rubescens
Elk sedge	Carex geyeri
Giant wild-rye	Elymus cinereus
Idaho fescue	Festuca idahoensis
Junegrass	Koeleria cristata
Timothy	Phleum pratense
Kentucky bluegrass	Poa pratensis

Herbs

Western yarrow	Achillea millefolium
Dogbane	Apocynum androsaemifolium
Arrowleaf balsamroot	Balsamorrhiza sagittata
Indian paintbrush	Castilleja spp.
Goldthread	Coptis occidentalis
Fireweek	Epilobium angustifolium
Larkspur	Delphinium bicolor
Wild daisy	Erigeron spp.
Sulphur plant	Eriogonum umbellatum
Wild strawberry	Fragaria virginiana
Bedstraw	Galium boreale
Wild geranium	Geranium viscosissimum
Alumroot	Heuchera glabella
Common St. Johnswort	Hypericum perforatum
Lupine	Lupinus spp.
Yellow sweetclover	Melilotus officinalis
Mountain bluebell	Mertensia spp.
Penstemon	Penstemon spp.
Cinquefoil	Potentilla spp.
Western bracken	Pteridium aquilinum
Arrowleaf butterweed	Senecio triangularis
Goldenrod	Solidago spp.
Meadowrue	Thalictrum spp.
False-hellebore	Veratrum viride
Beargrass	Xerophyllum tenax

Important animal species

Common name	Scientific name
Northwest white-tailed deer	Odocoileus virginianus ochrourus
Rocky mountain deer mule deer	Odocoileus hemionus hemionus
Rocky mountain elk	Cervus candensis nelsoni
Shiras moose	Alces shirasi
Mountain caribou	Rangifer arcticus montanus
Mountain goat	Oreamnos americanus
Black bear	Ursus americanus
Coyote	Canis latrans
Canada lynx	Lynx canadensis
Bobcat	Lynx rufus
Mountain lion	Felis concolor

Appendix B. Statistical Treatment

Many decisions have to be made by the technician regarding sampling techniques, sample size and location, and appropriate statistical techniques for analysis of the data. Certain basic assumptions must also be made regarding floristic sampling.

Dr. Howard Reinhardt (1959) of the mathematics department at Montana State University advised me on this phase of the study. The assumptions for analysis of variance are so restricted that he felt that chi-square would be a more useful tool to evaluate the data. He also suggested the assumption that point-plots along a line are equivalent to a random sample of points.

The distribution in chi-square is only an approximate one. Fraser (1958, p.270) stated:

> Fortunately there is an approximation for the hypothesis distribution of chi-square and the approximation is quite good for sample sizes large enough that the expected frequency in each cell is five or greater. The approximating distribution is the chi-square distribution.

The mean occurrence (Tables 25, 27, 29, 31 and 33) was calculated by using a series of 20 point-plots as replication on the transect line to test plant species for uniformity of distribution.

Expressed in terms of density (plants per unit area) these observations should have mean and variances about equal and this tends to be the case. The total hits on any plant species out of the highest possible number of hits was used to determine the relative frequency.

Each set of point-plots constitutes one observation. The number of

hits (x) recorded for any given plant species divided by the total possible hits (n) gives the value x/n. The upper and lower confidence limits for this value were then taken from the Clopper and Pearson charts as presented by Adams (1951).

The sampling in this study confirms the results of Heady et al., (1959) that point-plot and line intercept results are comparable (Table 32). If the assumption that the two techniques are equal is a valid one then we would expect no significant difference, which was the case for most of the species tested. The assumption for Tables 26,28, 30,34, 35 and 36 is that treatment is responsible for differences observed, and not due to sampling error. In some cases the difference in treatment is logging vs. an undisturbed condition (Tables 26, 28 and 30). In others it is one logging age vs. an older logging history (Tables 34, 35 and 36). Table 28 also includes a recent burn so that all three conditions of control, cut, and cut and burn were tested simultaneously while using two degrees of freedom.

Table 25. Plant composition and abundance on grand fir sites; unlogged and one year after logging; Downey Creek, Shoshone County (measured in 1957)

Species	Hits	Mean occurrence per 20 plots	Standard deviation	Relative frequency (in percent)	Confidence limits (95%)[a] Upper	Lower
(S3) Unlogged control						
Pachistima	194	12.9	3.1	47.0	52	42
Vaccinium	48	3.2	3.0	11.7	16	9
Grand fir	41	2.7	1.7	10.0	13	7
White pine	30	2.0	1.8	7.3	9	5
Serviceberry	22	1.5	2.2	5.4	7	3
Spiraea	16	1.1	1.3	3.9	6	3
Misc.[b]	61	--	--	14.7	--	--
TOTAL	412			100.0		
(S4) Logged one year						
Pachistima	221	5.52	3.64	24.3	28	21
Vaccinium	95	2.38	2.98	10.4	12	8
Rubus	77	1.92	2.71	8.5	10	6
Mountain maple	72	1.80	3.42	7.9	10	6
Spiraea	71	1.78	1.56	7.8	10	6
Serviceberry	51	1.28	1.48	5.6	6	4
Oceanspray	45	1.13	1.53	4.9	6	4
Misc.	278	--	--	30.6	--	--
TOTAL	910			100.0		

[a]After Adams, Lowell (1951).
[b]The "Misc." total (Tables 25, 27, 29, 31, and 33) includes all plants, of less than 1 percent occurrence, plus hits on herbaceous species, slash and bare ground.

Table 26. Statistical comparison of the effects of logging on plant abundance on grand fir sites, Downey Creek, Shoshone County (measured in 1957)

Species	(S3) Unlogged control Hits	(S4) Logged one year Hits
Pachistima	194	221**
Vaccinium	48	95
Grand fir	41	37**
White pine	30	15**
Serviceberry	22	51
Spiraea	16	71*
Rose	13	22
Snowberry	11	25
Mountain ash	10	10
Oceanspray	9	45*
Mountain maple	5	72**
Rubus	0	77**
Misc.[a]	13	169
TOTAL	412	910

*Chi-square significant at the 95 percent level.
**Chi-square significant at the 99 percent level.
[a]The "Misc." total (Tables 26, 28, 30, 32, 34, 35 and 36) includes shrubby plants of small expected frequencies, plus hits on herbaceous species, slash, and bare ground.

Table 27. Plant composition and abundance on grand fir sites; unlogged and one year after logging and burning; Ash Creek, Shoshone County (measured in 1957)

Species	Hits	Mean occurrence per 20 plots	Standard deviation	Relative frequency (in per-cent)	Confidence limits (95%) Upper	Lower
(S5) Unlogged control						
Pachistima	143	7.15	4.72	34.2	39.0	29.0
Vaccinium	61	3.10	3.70	14.6	19.0	11.0
Rose	34	1.70	2.80	8.1	12.0	6.0
Misc.	180	-	-	43.1	-	-
TOTAL	418			100.0		
(S6) Recently logged						
Pachistima	123	6.15	3.55	29.7	35.0	25.0
Vaccinium	29	1.45	1.60	7.0	11.0	4.0
Grand fir	28	1.40	2.22	6.8	11.0	4.0
Rose	23	1.15	1.90	5.6	9.0	4.0
Spiraea	21	1.05	1.36	5.1	7.0	3.0
Oregon grape	18	0.90	1.09	4.3	6.0	2.0
Misc.	172	-	-	41.5	-	-
TOTAL	414			100.0		
(S7) Recently logged and burned						
Redstem ceanothus	114	4.56	4.66	22.8	28.0	19.0
Spiraea	19	0.76	1.14	3.8	7.0	3.0
Rose	16	0.64	1.40	3.2	7.0	3.0
Misc.	351	-	-	70.2	-	-
TOTAL	500			100.0		

Table 28. Statistical comparison of the effects of logging on plant abundance on grand fir sites; Ash Creek, Shoshone County, (measured in 1957)

Species	(S5) Unlogged control Hits	(S6) Logged one year Hits	(S7) Logged one year and burned Hits
Pachistima	143	123	1**
Vaccinium	61	29	0**
Rose	34	23	16**
Snowberry	9	3	8
Oregon grape	4	18	5**
Grand fir	4	28	0**
Spiraea	2	21	19**
Redstem ceanothus	0	0	114**
Misc.	161	169	337
TOTAL	418	414	500

**Chi-square significant at the 99 percent level.

Table 29. Plant composition and abundance on grand fir sites; unlogged and seven years after logging; Jupiter Creek Plots, Shoshone County (measured in 1957)

Species	Hits	Mean occurrence per 20 plots	Standard deviation	Relative frequency (in percent)	Confidence limits (95%) Upper	Lower
(S8) Unlogged control						
Rose	41	2.05	1.94	9.5	14.0	8.0
Vaccinium	38	1.90	2.23	8.8	13.0	7.0
Hemlock	26	1.30	1.70	6.0	9.0	4.0
Misc.	325	-	-	75.7	-	-
TOTAL	430			100.0		
(S9) Logged 7 years						
Oregon grape	70	3.2	2.71	14.1	18.0	11.0
Snowberry	68	3.1	3.87	13.7	18.0	11.0
Spiraea	47	2.1	2.33	9.5	14.0	8.0
Rubus	43	1.9	2.44	8.7	13.0	6.0
Rose	29	1.3	1.39	5.9	9.0	4.0
Serviceberry	27	1.2	1.44	5.5	9.0	4.0
Misc.	212	-	-	42.6	-	-
TOTAL	496			100.0		

Table 30. Statistical comparison of the effects of logging on plant abundance on grand fir sites; Jupiter Creek, Shoshone County, (measured in 1957)

Species	(S8) Unlogged control Hits	(S9) Logged seven years previously Hits
Rose	41	29*
Vaccinium	38	23*
Hemlock	26	0**
Snowberry	16	68**
Oregon grape	16	70**
Grand fir	16	8
Pachistima	15	3**
Serviceberry	9	27*
Rubus	6	43**
Spiraea	5	47**
Misc.	242	178
TOTAL	430	496

*Chi-square significant at the 95 percent level.
**Chi-square significant at the 99 percent level.

Table 31. Plant composition and abundance on one Douglas fir site, 21 years after logging; Horse Ridge, Kootenai County (measured in 1959)

Species	Hits	Mean occurrence per 20 plots	Standard deviation	Relative frequency (in percent)	Confidence limits (95%) Upper	Lower
(K3) Line intercept, 21 years after logging						
Oceanspray	309			26.1	30.0	22.0
Ninebark	128			14.7	18.0	12.0
Snowberry	95			11.8	15.0	10.0
Redstem ceanothus	74	b	b	9.3	12.0	7.0
Rose	40			5.1	6.0	4.0
Serviceberry	31			3.9	5.0	3.0
Willow	31			3.9	5.0	3.0
Douglas fir	29			3.6	5.0	3.0
Chokecherry	19			2.4	4.0	2.0
Misc.	44			-	-	-
TOTAL	800					
(K3) Line points, 21 years after logging						
Oceanspray	332	7.31	4.58	31.6	35.0	29.0
Ninebark	129	3.37	3.69	12.3	15.0	10.0
Snowberry	118	3.09	4.00	11.2	13.0	9.0
Redstem ceanothus	83	2.12	3.30	7.9	10.0	6.0
Rose	64	1.67	3.22	6.1	8.0	5.0
Serviceberry	32	1.80	3.20	3.0	5.0	2.0
Douglas fir	28	0.73	1.41	2.6	5.0	2.0
Willow	23	0.60	1.06	2.1	4.0	2.0
Ponderosa pine	22	0.55	1.10	2.0	4.0	2.0
Chokecherry	19	-	-	1.7	4.0	2.0
Misc.	200	-	-	-	-	-
TOTAL	1050					

[b]Intercept records were not recorded in 20-foot units, hence mean occurrences per 20 plots cannot be calculated here.

Table 32. Statistical comparison of two plant measurement techniques, line intercepts and line points, on a Douglas-fir site, Horse Ridge, Kootenai County, 21 years after logging

Species	Horse Ridge (K3) Line intercept[c] Cut, 1938, Meas. 1959		Line points Cut, 1938, Meas. 1959
Oceanspray	309	**	332
Ninebark	128	*	129
Snowberry	95		118
Redstem ceanothus	74		83
Rose	40		64
Serviceberry	31		32
Willow	31	*	23
Douglas fir	29		28
Chokecherry	19		19
Ponderosa pine	4	**	22
Misc.	40		200
TOTAL	800		1050

*Chi-square significant at the 95 percent level.
**Chi-square significant at the 99 percent level.
[c]One foot of intercept equals one point plot (interpreted here as hits).

Table 33. Plant composition and abundance on Douglas-fir sites, logged 11 and 21 years previously, at Thompson Ridge and Horse Ridge, Kootenai County (measured in 1957)

	Species	Hits	Mean occurrence per 20 plots	Standard deviation	Relative frequency (in percent)	Confidence limits (95%) Upper	Lower
(K2)	Thompson Ridge						
	Snowberry	134	6.1	3.2	28.8	34.0	24.0
	Oceanspray	86	3.9	3.1	18.5	24.0	15.0
	Rose	48	2.2	2.0	10.3	13.0	7.0
	Serviceberry	47	2.1	1.9	10.1	13.0	7.0
	Redstem ceanothus	14	0.6	0.8	3.0	4.0	2.0
	Misc.	136	-	-	29.3		
	TOTAL	465			100.0		
(K3)	Horse Ridge						
	Oceanspray	262	12.48	3.5	55.6	61.0	51.0
	Snowberry	54	2.57	2.0	11.5	16.0	9.0
	Redstem ceanothus	25	1.19	1.8	5.3	8.0	3.0
	Rose	23	1.10	1.6	4.9	8.0	3.0
	Ninebark	18	0.86	2.0	3.8	6.0	2.0
	Misc.	89	-	-	18.9	-	-
	TOTAL	471			100.0		

Table 34. Statistical comparison of the effects of logging on Douglas-fir sites, 11 and 19 years after logging; at Thompson Ridge and Horse Ridge, Kootenai County, (measured in 1957)

Species	(K2) Thompson Ridge Hits		(K3) Horse Ridge Hits
Snowberry	134	**	54
Oceanspray	86	**	262
Rose	48	**	23
Serviceberry	47	**	13
Spiraea	16	**	3
Willow	16	**	2
Redstem ceanothus	14		25
Misc.	104		89
TOTAL	465		471

**Chi-square significant at the 99 percent level.

Table 35. Statistical comparison of the effects of logging on a Douglas-fir site; at Horse Ridge, remeasured after a two-year lapse, Kootenai County

Species	(K3) Horse Ridge cut 1938, meas. 1957 Hits		(K3) Horse Ridge cut 1938, meas. 1959 Hits
Oceanspray	262	**	332
Snowberry	54		118
Redstem ceanothus	25		83
Rose	23		64
Ninebark	18	**	129
Serviceberry	13		32
Chokecherry	11		19
Willow	2	*	23
Misc.	63		250
TOTAL	471		1050

*Chi-square significant at the 95 percent level.
**Chi-square significant at the 99 percent level.

Table 36. Statistical comparison of the effects of logging on a Douglas-fir site; at Horse Ridge, remeasured after a six-year lapse, Kootenai County

Species	(K3) Horse Ridge Cut 1938, meas. 1953 Hits		Cut 1938, meas. 1959 Hits
Redstem ceanothus	1002[c]	**	74[c]
Oceanspray	813	**	309
Snowberry	240		95
Rose	237	**	49
Chokecherry	156	**	19
Ninebark	126	**	118
Vaccinium	114	**	0
Serviceberry	87		31
Mock orange	87	**	3
Willow	57	**	31
Douglas-fir	54	*	29
Ponderosa pine	54	**	4
Grand fir	18	*	0
Misc.	24		202
TOTAL	3069		964

*Chi-square significant at the 95 percent level.
**Chi-square significant at the 99 percent level.
[c]One foot of line intercept equals one point plot (interpreted here as hits).

LITERATURE CITED

Adams, Lowell. 1951 Confidence limits for the Petersen or Lincoln index used in animal population studies. J. Wildl. Mgmt. 15(1): 13-19.

_____. 1958. Personal communication.

Allen, Durward. 1950. Problems and needs in pheasant research. J. Wildl. Mgmt. 14 (2): 105-114.

Anonymous. 1937, 1938. Forest statistics for Shoshone and Kootenai Counties, Idaho. N. Rky. Mtn. For. & Range Expt. Sta., For. Survey Release 11, Missoula, Mont.

Anonymous. 1916-53. Climatological Bulletin, Idaho. U. S. Weather Bureau, Boise.

Basile, Joseph V. 1954. Availability of white-tailed deer browse within the Hatter Creek enclosure. M.S. thesis (unpubl.) Univ. of Idaho.

Brown, Dorothy. 1954. Methods of surveying and measuring vegetation. Brit. Commw., Bur. Pastures & Field Crops. Bull. 42 pp.

Brown, Dudley. 1936. Winter game report. U.S.F.S., Coeur d'Alene National Forest files, Idaho.

Campbell, Marius. 1915. Northern Pacific Railway Guide, U.S. Geol. Survey, U. S. Gov't. Prtg. Off., Wash., D. C.

Canfield, R. H. 1941. Application of the line interception method in sampling range vegetation. J. For. 39(4): 388-394.

_____. 1950. Sampling ranges by the line interception method. Report 4., S.W. For. and Range Expt. Sta.

Carter, Harry G. 1941. Supplemental climatic notes for Idaho. (in Climate and Man) U.S.D.A. yearbook, U.S. Gov't. Prtg. Off. xii + 1248 pp.

Carter, Richard L. 1951. An environmental analysis of winter game range in western Montana. M.S. thesis, (unpubl.) Mont. State Univ.

Cheatum, E. L. 1949. Bone marrow as an index to malnutrition in deer. N.Y. State Conservationist. 3(5): 19-22.

_____. 1951a. Personal communication.

Cheatum, E. L. 1951b. Disease in relation to winter mortality of deer in New York. J. Wildl. Mgmt. 15(2): 216-220.

_____. 1952. On the population dynamics of big game. Proc. Mont. Acad. Sci. 11: 47-56.

_____, and C. W. Severinghaus. 1950. Variations in fertility of white-tailed deer related to range conditions. Trans. 15th N. A. Wildl. Conf. : 170-190.

Cooper, Charles F. 1959. Cover vs. density. J. Range Mgmt. 12(4): 215.

Costley, Richard J. 1948. Crippling losses among mule deer in Utah. Trans. 13th N. A. Wildl. Conf.: 170-190.

Cowan, Ian McTaggart. 1951. The diseases and parasites of big game mammals of western Canada. Report of Proc. of 5th Annual British Columbia Game Conven.

_____. 1956. Life and times of the coast black-tailed deer. (In Taylor, The deer of North America).

Daubenmire, Rexford. 1945. Plant geography of Idaho, (in Davis, 1952, cited below).

_____. 1952. Forest vegetation of northern Idaho and adjacent Washington, and its bearing on concepts of vegetation classification. Ecol. Monog., 22: 301-330.

_____. 1959. A canopy-coverage method of vegetational analysis. N. W. Sci., 22(1): 43-64.

Davis, Ray J. 1952. Flora of Idaho, Brown Pub. Co., Dubuque, Ia. 828 pp.

Edwards, R. V. 1956. Snow depths and ungulate abundance in the mountains of western Canada. J. Wildl. Mgmt. 20(2): 159-168.

Fraser, D. A. S. 1958. Statistics, an introduction. John Wiley and Sons, Inc. New York, 398 pp.

Gill, John D. 1956. Review of deer year management. Game Div. Bull. 5, Dept. of Inland Fisheries and Game, Augusta, Me.

Graham, Samuel, 1954. Changes in northern Michigan forests from browsing by deer. Trans. 19th N. A. Wildl. Conf.: 526-533.

Heady, Harold, Robert P. Gibbens and Robert W. Powell. 1959. A comparison of the charting, line intercept and line point methods of sampling shrub types of vegetation. J. Range Mgmt. 12(4): 180-188.

Henderson, John. 1903. History of North Idaho, Western Historical Publ. Co., Chicago, Ill.

Hickie, Paul. 1957. The application of ecology to wildlife management. Ecology 38(1): 53-56.

Hutchison, S. Blair, and R. K. Winters. 1942. Northern Idaho forest resources and industries, U. S. D. A. Misc. Pub. 508.

Ingram, Douglas C. 1931. Vegetative changes and grazing use on Douglas fir cut-over land. J. Agric. Res., 43(5): 387-417.

Interstate Deer Herd Committee. 1951. The Devils Garden deer herd. Calif. Fish & Game 37(3): 233-272.

Johnston, Alex. 1956. A comparison of the line interception, vertical point quadrat and loop methods as used in measuring basal area of grassland vegetation. Canadian J. Plant Sci. 37: 34-42.

Kelker, George H. 1944. Sex-ratio equations and formulas for determining wildlife populations. Proc. Utah Acad. Sci., Arts & Letters 19: 189-198.

_____. 1947. Computing the rate of increase for deer. J. Wildl. Mgmt. 11(2): 177-183.

_____. 1952. Yield tables for big game herds. J. For. 50(3): 206-207.

Kellogg, Remington. 1956. What and where are the whitetails? (In Taylor, The deer of N. America, cited below).

Kittredge, Joseph. 1948. Forest influences. McGraw-Hill Book Co., N.Y., 394 pp.

Krefting, L. W., H. L. Hansen and M. H. Stenlund. 1956. Stimulating regrowth of mountain maple for deer browse by herbicides, cutting, and fire. J. Wildl. Mgmt. 20(4): 434-441.

Lauckhart, J. B. 1950. Determining the big game population from the kill. Trans. 15th N. A. Wildl. Conf.: 644-650.

Longhurst, W.M., A. S. Leopold and R. F. Dasmann. 1952. A survey of California deer herds, their ranges and management problems. Calif. Fish and Game Dept. Game Bull. 6: 1-136.

McCulloch, Clay Y. Jr. 1955, Utilization of winter browse on wilderness big game range. J. Wildl. Mgmt. 19(2): 206-215.

Morton, Allen D. 1950. Sampling yields and utilization of browse on winter deer range in northern Idaho. M.S. thesis (unpubl.), Univ. of Idaho.

Mullan, John. 1863. Report on the construction of a military road from Fort Walla Walla to Fort Benton, Wash. D.D., Gov't. Prtg. Off.

Murie, Olaus J. 1951. The elk of North America, Stackpole Co., Harrisburg, Pa., pp. 376.

Parker, K. W., and D. A. Savage. 1944. Reliability of the line interception method in measuring vegetation on the southern Great Plains. J. Am. Soc. Agron. 36: 97-110.

Pengelly, W. Leslie. 1954. Coeur d'Alene deer management study completion report. Idaho Fish & Game Dept., Project Report W-90-R, 213 pp.

_____, and Robert L. Casebeer. 1949-51. Quarterly Progress Reports, 90R1, 90R2, Idaho Fish & Game Dept., Boise.

Reinhardt, Howard J. 1959. Personal communication.

Robinette, W. Leslie. 1949. Winter mortality among mule deer in the Fish Lake National Forest, Utah. U.S. Fish & Wildl. Serv. Spec. Report Nol 65. Wash. (Processed).

_____. 1956. Productivity, the annual crop of mule deer. (In Taylor, The deer of North America, 1956, cited below).

Rogers, Ray. 1959. Personal communication.

Selleck, David M., and Chester M. Hart. 1957. Calculating the percentage of the kill from sex and age ratios. Calif. Fish and Game, 43(4): 309-315.

Severinghaus, W. C. 1947. Relationship of weather to winter mortality and population levels among deer in the Adirondack region of New York. Trans. 12th N. A. Wildl. Conf.: 212-223.

_____. 1947. 1949. Tooth development and wear as a criteria of age in white-tailed deer. J. Wildl. Mgmt.: 13(2) 195-216.

_____. 1953. Personal communication.

_____, and E. L. Cheatum. 1956. Life and times of the white-tailed deer. (In Taylor, The deer of North America).

Sayama, Kenji. 1952. Personal communication.

Stoddart, L. A. and Arthur D. Smith. 1943. Range Management. McGraw-Hill Book Co., N. Y. 547 pp.

Taber, Richard D. 1951. The influence of chapparal management on Columbian black-tailed deer populations. Doctor's thesis, Univ. of Calif., pp. 111.

_____. 1955. Deer nutrition and population dynamics in the north coast range of California. Trans. 21st N.A. Wildl. Conf. 160-172.

_____. 1959. Personal communication.

_____, and Raymond F. Dasmann. 1958. The black-tailed deer of the chaparral. Game Bull. 8, Calif. Dept. of Fish & Game, 163 pp.

Taylor, Walter P. 1956. (Ed.) The deer of North America. Harrisburg, Pa.,Stackpole Co., 668 pp.

Thwaites, R. G. 1905. (Ed.) Original journals of the Lewis and Clark Expedition, 1804-1806. N. Y., Dodd, Mead & Co.

U. S. Forest Service. 1921-1959. Annual game reports, Coeur d'Alene National Forest files.

U. S. Forest Service. 1957. Wildlife management handbook for forest officers. U. S. D. A. Region 1, 217 pp.

Waters, Charles W. 1959. Personal communication.

Webb, William L. 1948. Environmental analysis of a winter deer range. Trans. 13th N. A. Wildl. Conf.: 442-450.

White, Catherine M. 1950. (Ed.) David Thompson's Journals, 1808-1812. Missoula; Montana State Univ.

Whitlock, S. C. 1939. The prevalence of disease and parasites in white-tail deer. Trans. 4th N. A. Wildl. Conf.: 244-249.

Woolfolk, Joseph. 1952a. Personal communication.

_____. 1952b. Some observations on a white-tailed deer winter range in Idaho. Range Research Hi-Lites, N. Rky. Mtn. For. & Range Exp. Sta., Reg. 1, Missoula, Mont.